# ROADS AND STREETS

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## A Plea for Special Freight Rates on Road Show Exhibits

American railways have been asked to grant a special rate on equipment shipped for exhibition at the annual Road Show. We understand that certain railways have replied that special freight rates are prohibited under the scheduled tariffs approved by state and national railway commissions. Doubtless this is so, but it is equally certain that these commissions will approve any convention rates that the railways may submit. The commissions have never objected to the one-and-a-half passenger fares for round trips to conventions, because it is obvious that such special fares greatly encourage attendance at conventions.

Should it be argued that exhibitors need no such encouragement, the reply is that very few annual exhibitions of heavy machinery have been repeated many years, because of the great expense involved in transporting the machinery. The Road Show, it is true, has survived even this great burden for several years; but many a former exhibitor has dropped out of the picture, and many others annually ask themselves whether it will pay to attend again.

It should be remembered that the great annual Cement Show finally came to an end because of the expense involved, an expense that consisted very largely in shipping heavy machinery to and from the show.

The exhibits at the two annual waterworks conventions have been reduced in size until many exhibitors now show only models. This reduces the value of the shows and thus tends to decrease the number who attend them.

Not only will the railway companies lose income directly if the Road Show exhibits dwindle, and the attendance declines in consequence, but they will lose much more income indirectly, for the Road Show has been one of the greatest of educational institutions. It has taught thousands of men the value of labor-saving machinery, and has stimulated the development of highways. This, of course, has added greatly to the volume of freight hauled by railways.

There may still be a few short-sighted railway officials who regard paved roads as serious competitors, and who therefore would oppose granting special freight rates to exhibitors at road shows. But the majority of railway officials have come, we believe, to regard road transportation as supplementary to rail transportation, and no more to be dreaded than air-mail transportation.

Foreigners have often said that Americans are "convention crazy"; and we are seemingly so, for we attend exhibits and listen to essays and debates on all trade and professional subjects from the hatching of chicks to the discovering of stars. Those who ridicule us as "joiners" and "attenders" are not disparaging us as "producers," for we have outstripped every nation in productive capacity. Not the least of the reasons why we are envied as the wealthiest of peoples is our joining and attending habit. It is thus that we gain much of our knowledge, by swapping ideas and by seeing the latest in mechanical devices and materials.

There is, moreover, an inspiration in meeting men of whom you have heard, and even merely in seeing great crowds of men who are engaged in the same business that you follow. The joiner and attender goes home from a convention the richer not merely in new ideas, but in confidence that he is playing an important role himself in a great industry. All this stimulates him to keep out of the ruts, to read the literature and the advertisements relating to his specialty, to scrap the old and buy the new—to be a typical American. Because he is progressive, an American consumes far more rail-hauled produce than does the typical citizen of any other nation.

Granted? Then grant also that our American conventions have aided greatly in making us the greatest patrons of railways in the world.

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## The Kinship of All Nature

One of the greatest of mathematical geniuses was Prof. Colin Maclaurin, of the University of Edinburgh, a contemporary of Sir Isaac Newton and author of a book on the latter's scientific discoveries. The closing words of that book of Maclaurin's are:

"New knowledge does not consist so much in our having access to a new object, as in comparing it with others already known, observing its relations to them, or discerning what it has in common with them, and wherein their disparity consists. Thus our knowledge is vastly greater than the sum of what all its objects could separately afford; and when a new object comes within our reach, the addition to our knowledge is greater, the more we already know; so that it increases not as the new objects increase, but in a much higher proportion."

To this philosophic generalization it may be added that all the phenomena of nature are kin to one another, and to an extent scarcely dreamed of in 1746 when Maclaurin penned the finis to his great (but not his greatest) book. Newton had died 18 years before that, or just two centuries ago, and Maclaurin was perhaps his most ardent admirer; so ardent indeed that he said of Newton that, in so far as astronomy was concerned, "Newton left to posterity little more to do, but to observe the heavens, and compute after his models."

But when Maclaurin wrote in 1746 the spectroscope had yet to be invented, photography was unknown and electricity was just beginning to receive scientific attention. Thirteen years yet remained before Halley's comet was to return and verify that great astronomer's forecast that at least some comets are kin to planets; being satillites of the sun. No hypothesis of the genesis of the solar system had yet been framed. Geology was in its swaddling clothes, and Darwin's theory was a century in the future.

Even this very brief enumeration indicates the meagerness of scientific knowledge less than two centuries ago. Yet it is hardly to be doubted that two centuries

hence our present store of scientific facts and proven theories will seem relatively as small to the then living scientists as that of Newton's day seems now to us.

Maclaurin was right. Scientific knowledge increases in geometric ratio. The more we acquire of it the easier it becomes to acquire still more. Kinships disclose themselves that were never suspected. The mightiest stars travelling in their orbits, forming parts of vast systems, are much like the invisible electrons that revolve incredibly fast about a central "sun" and so form atoms. The infinitely great is brother to the infinitely small.

A sunspot 50,000 miles in diameter is very like a yard-wide dust whirl we see on a summer day. Both are kin electric phenomena; and each is capable of teaching us much about the other. In fact it is only because of such kinships that man can rapidly expand his scientific knowledge.

The slightest similiarity between any two phenomena, however great their dissimiliarity, should cause the thinking man to pause, asking himself if this may not be a key that will open some important door to knowledge. Likenesses never occur singly. Nature uses the same general patterns in countless sizes, in endless shadings, and with numberless camouflages. The old dame delights in concealing these kinships. She shows you a red rose and a green leaf. Very different as to color, form and function; but the physicist will tell you that red and green are both ether waves, differing only in wave length; while the biologist will tell you that the parent of the petal is the leaf, and that the living element in both is protoplasm.

The other day a chemist found that the percentage of different salts in the blood is almost the same as in sea water; whence it is inferred that our marine progenitors merely siezed a little of the sea about them and pumped it through their protoplasm, thus generating the first blood. Though "blood is thicker than water," it is essentially sea water tinctured with a few corpuscles.

The similarity of gravitational pull to magnetic pull long ago led to the hypothesis that gravitation is an electric phenomenon. But physicists have been unable to prove it. It is a more probable hypothesis that gravitation and magnetism are simply varieties of ether waves, differing in wave length and in some other quantitative respect.

The instinctive tendency of all men to generalize is itself evidence that nature is characterized by kinships. Thus, if a child is stung by a snake, he is apt to reason thereafter that all snakes are poisonous. When Kepler found that orbit of one planet was elliptical, he assumed at once that all planet orbits are elliptical. So the child and the astronomer alike generalize instinctively from a single experience. Logicious condemn such analogical reasoning as being inconclusive and often defective; but the fact remains that it is the only sort of reasoning that leads to discoveries of natural laws; for in every recorded instance of a discovery of a natural law by aid of reason analogy has been the guide. Analogy leads investigators up many a blind alley, but analogy still remains the only sort of leadership to knowledge of new truths. The reason is that all natural phenomena are kin to one another, and that an analogy is some sore of kinship. Then by applying the rule that likeness in one respect is always associated with likeness in other respects ,the investigator is led to search for the other respects.

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# Will Washington "Become an Engineering Laboratory" Under Hoover?

One of the political critics of Herbert Hoover fears that, if elected president, Hoover will convert Washington into "an engineering laboratory." A little knowledge of the nature of such a laboratory might have led the critic to hope for Hoover's election.

An engineering laboratory is a place where guesswork ceases and precise measurements begin. An engineering laboratory is a place where facts reign and hot-air abdicates. An engineering laboratory is certainly not a hall of congress nor a house of parliament. Men do not congregate in an engineering laboratory to parade their sarcasm, their humor, or their book-learned wisdom. They come to such a laboratory to experiment and to test, guiding both experiment and tests with established theories, and measuring results with such precision that debate has no reason for existence.

Debate, if you stop to consider it, is an evidence of ignorance. Two or more men can not agree as to a theory or a policy, so they start an argument about it. Instead of spending their time seeking facts that would end all doubt, and therefore all argument, they resort to the easier expedient of giving vent to vocalizations that act like using gasoline as a fire extinguisher.

After listening to a parliamentary debate for three weeks, Herbert Spencer, the great English philosopher and engineer, was asked what he thought of the result. "Well," he said, "if they had selected the least brilliant of their members, and had let him spend those three weeks in searching for facts, the result could scarcely have failed to be better." The debate, as we remember, was over the diversion of the headwaters of the Thames. for some industrial purpose. It was contended that the proposed diversion menaced shipping on the Thames. Spencer pointed out that an engineer could have shown them that the diverted water would not lower the Thames one sixteenth of an inch.

Hoover has gone a long way toward converting his department of commerce into an engineering laboratory, and with results that are lauded by the business men of the country. There is not the slightest reason why every other governmental department should not be similarly systematized and thus brought within the jurisdiction of engineering methods.

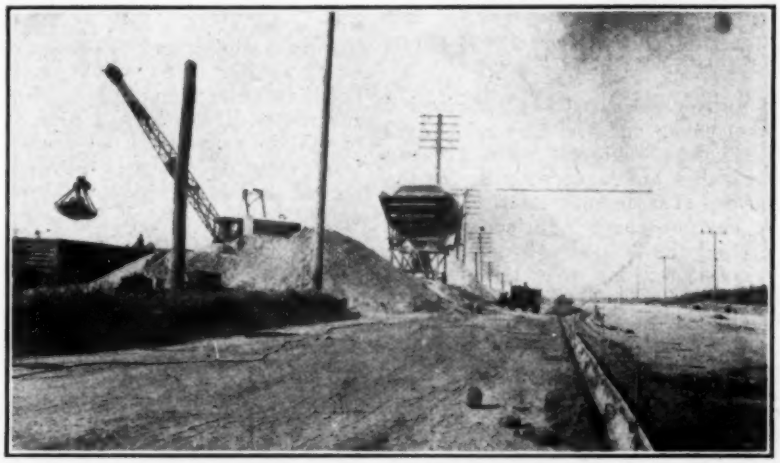
Engineering is the systematic application of science, and science is classified knowledge together with explanations of effects by tracing them to their causes. What is there, then, about either science or engineering that should cause critics to object to Hoover as president? The objection clearly springs from ignorance of the fundamental nature of engineering and of science.

H. P. Gillette

# Truck and Batch-Box Methods Used On Different Sections of Same Project

## Methods of Contractor and State Forces On Federal-Aid Highway Project Differ

A FEDERAL-AID project now partially completed, in the State of Illinois, will provide a 40 ft. concrete pavement between Kankakee and Chicago. This project, on new location most of the way, and running parallel to the right-of-way of the Illinois Central Railroad, involves about 40 miles of new highway. Approximately 25 miles, or 4 sections, were under contract this season. Three of these sections were let to a prominent contracting firm, while one section was paved by State forces. It is an interesting point that the contractor operated on the basis of truck haulage, while the State job was done with highly depreciated industrial haulage batch box equipment. A comparison of the methods and the progress made by both would prove of particular interest, since the conditions facing the various organizations were comparable and since the work to be done was the same. The factors that differed were then those of equipment, management, and efficiency of personnel.



Batcher Plant on Contract Near Peotone

**The Grading.**—The country traversed by the project is gently rolling farm land, with few and small watercourses, very few towns and these of a very small size, and with but a minimum number of railway and highway crossings except at the north end of the project. The soil is mostly a hard clay, with possibly a foot of loam on the surface. For the most part grading was fairly light, and location ideal, as attested by the fact that it approximated that chosen for the important railroad whose right-of-way was closely followed. Some heavy grading was encountered at Monee. Rough grading was done by means of elevating graders and dump wagons.

**Material Handling on Contract.**—Since all sections paved by the contractor were done with the same type of plant and the same methods, the description of all can be easily and briefly done by describing one. For this purpose, the work in the neighborhood of Peotone, Ill., will be described. Here, the material handling facilities and camp were located where the project comes within a few yards of the railway, just north of the town, centrally located in the section being paved. The aggregates and cement were delivered by rail on the Illinois Central, and these cars spotted on a siding. Cement was stored in the car and unloaded as needed for each batch, using a platform erected so that it would be at the car door, with the opened but not emptied sacks placed on each batch. A short distance away, along the same siding, aggregate cars were spotted opposite a two-compartment Johnson bin, and the aggregates unloaded into this bin or into stockpiles, as required, by means of a No. 104 Northwest crane equipped with a clamshell bucket. Batch trucks then obtained their loads from batchers suspended from the bottom of the bins, and proceeded from that point to the cement car for the cement for each batch.

Between the cement car and the paver, a platform was placed on the pavement. The batch trucks stopped at this platform, where the bags of cement were emptied onto the load and the sacks tossed to the roadside to be counted and baled. At this point of the operation, an opportunity was thus afforded for the inspector to check up on the number of bags of cement used for each batch, and the sack count gave the same sort of information for the benefit of the contractor. Thus, in the material department, the contractor used one craneman, one batch operator, five cement hands, one sack dumper on the stand and one sack laborer on empty sacks.

**Fine Grading.**—Before proceeding with the description of the plant and methods used in the actual paving methods, it would be well to consider the methods used on fine grading and the setting of the forms. While rough grading was done by means of tractor-operated elevating grader and blade

Views on Contract Sections—1—Grader Outfit Working on Rough Grading on Cameron-Joice Job. 2—Batcher Plant on Same Job. 3—Breaking Up Subgrade with Scarifier Drag Before Use of Grader for Fine Grading. The Soil Was Clay Baked by Hot Weather

grader outfits, fine grading was done with a scarifier towed by a tractor, a Hug subgrader, and a number of fresno teams. Light rolling was done with a Fordson made into a roller by putting on wide tread wheels filled with concrete. Forms were set after trench had been cut by a Carr formgrader. This machine, operated by one man, eliminated the usual pick and shovel crew used for preparing form trench, and forms could easily be set well ahead at a low cost.

**The Paver.**—The batches were hauled to the paver in five Chevrolet dual wheel trucks equipped with Anthony dump bodies holding one batch for the 27-paver. The number of trucks used each day, of course, varied with the length of haul. The five observed, were used on a day when the haul was rather short and when a progress of 1,000 lin. ft. of 20 ft. pavement were to be laid. The paver used on this work was the 27-E Koehring. The paver was operated on the subgrade for the first half of the pavement, the first 20 ft. strip, but on the second strip, in order to avoid tearing up the subgrade, the paver was operated on the completed first half, using a long boom. Using a one minute mix, a 1:2:3½ concrete with from 10 to 15 per cent extra sand to account for bulking, and 29 gal. of water to the 6-bag batch, this paver averaged 1,050 lin. ft. of 20 ft. Illinois section pavement in 11½ to 12 hours each day.

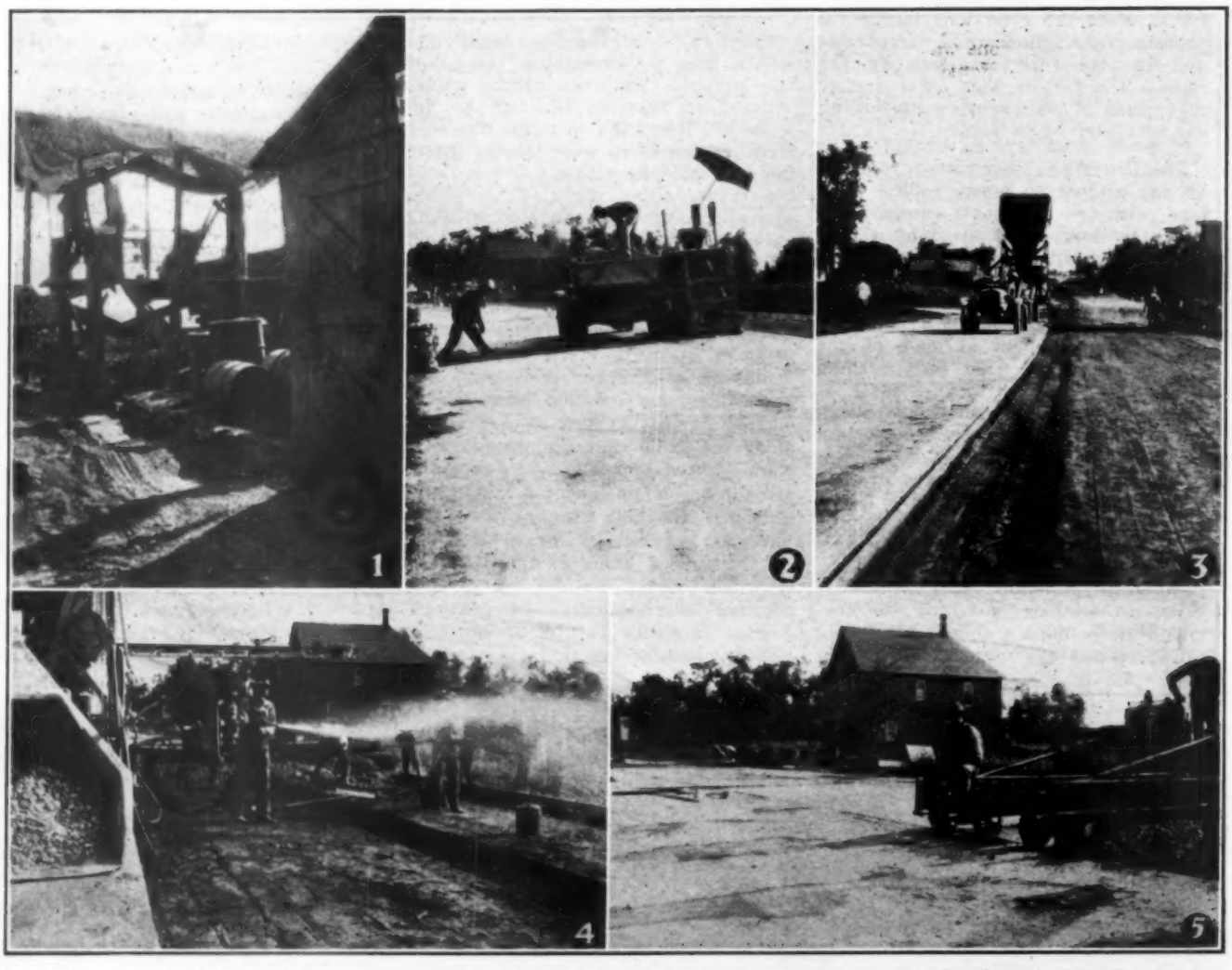
**Finishing.**—The finishing was done with a Lakewood finisher, followed by the usual edging and patching and float work. After the completion of the finishing operation, the surface was covered with wet burlap. Each morning the burlap spread the previous day was removed and calcium chloride spread upon the pavement for final curing.

**The Paving Crew.**—The actual paving operation was performed by a gang composed of one mixer operator, one finishing machine operator, one dumper, five spaders, four form men, and one steel laborer, plus two men on curing.

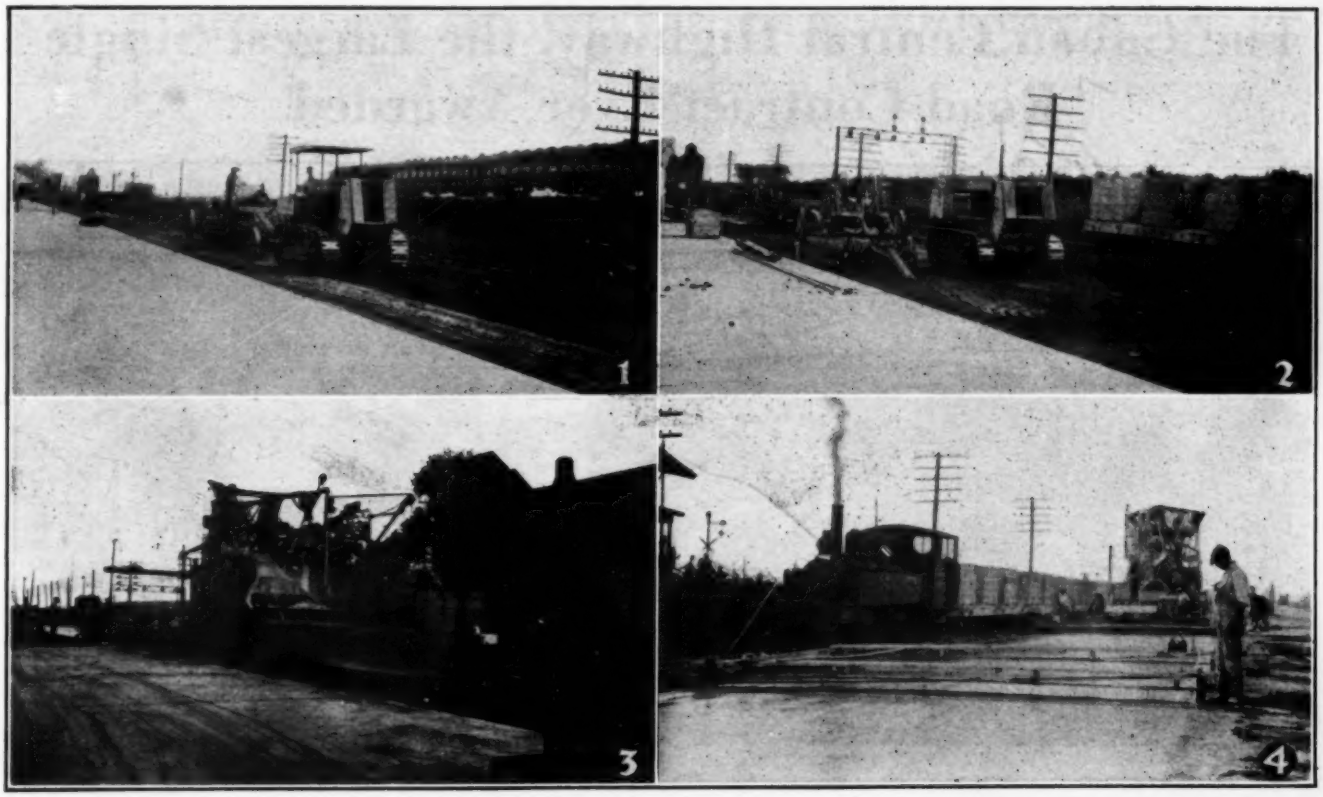
**The Contractor.**—The contractor on the three sections that were let out, whose work has been described above, was Cameron, Joyce & Co., of Keokuk, Iowa. They were represented by S. J. Clausen, superintendent. The state was represented on the work by Louis Bowman, resident engineer, under the direction of M. J. Fleming, district engineer, of the State Highway Department.

**State Paved a Section.**—One section of the route was paved by state forces, utilizing industrial haulage. This section, known as Section 140 of Route 49, the route being paved extends from Kankakee to Manteno, a distance of about 8 miles. Like the sections under contract, the job involves the paving of a 40 ft. concrete highway, made up of two thousand state sections with thickened edge, with the edge thickness 9 in. and the center thickness of each strip 7 in.

**Using War Equipment.**—On this job, the state forces were using surplus war equipment for the most part. This equipment was greatly depreciated and in bad condition, and said to be proving quite costly to maintain in service. Most of it, according to the engineer in charge, was to be scrapped at the end of the job. In spite of this condition of equipment, the organization was




More Views on Peotone Job. 1—Platform Between Cement Car and Trucks. 2—Platform Where Cement Sacks Are Emptied on Batches, Showing Dumper and Sack Baler. 3—Paver Operating on Completed Strip. 4—Closeup at Paver Showing Work Ahead of Finisher. 5—Finishing Machine and Work Behind Finisher



Views on State Section. 1—Fine Grading with Old Tractor. 2—More Grading Equipment and a Car of Batch Boxes. 3—View of Paver at Charging End with Batch Box Train Being Unloaded. 4—Another View at Paver, Showing Locomotive and Train, and the Finishing Operations

averaging 1,000 lin. ft. of 20 ft. pavement per 10 hour day and paved as much as 1,235 ft. on one day.

**Subgrading.**—Subgrading was done with a Western wheeled scraper pulled by an old army Holt 60 Caterpillar tractor, still equipped with the original armor plate, with two fresno teams, and with a slip scraper. This latter equipment was used on shoulder work as well.

**Material Deliveries.**—Materials were delivered by rail. A sand bin and a stone bin were set up at the siding, and the sand was handled by a 15-ton Industrial Works crane equipped with a clamshell bucket and the gravel by a similar crane rated at 25 tons. Stock piles were built up at this point to afford a reserve supply of both aggregates. Cement was delivered in box cars and unloaded by hand, the cement hands wheeling the cement from the cars to a platform alongside the track and from this platform to a cement shed that was erected nearby. The cement for the batches was then unloaded from this cement shed to the batch boxes as required.

The crew required on this part of the work included an operator and fireman for each crane, two bin men, two car cleaners, and 6 cement hands. Wheeling distance from the cement car to the cement shed was about 35 ft.

**Batch Transportation.**—The batches were transported to the paver in batch boxes on flat cars, made up into trains and pulled by narrow gauge locomotives. This haulage equipment, operating on 60 cm. gauge war surplus track, was old government equipment, as were the cranes. Six steam locomotives were used, as well as 36 flat cars of the old type, made up into 4 trains of 9 cars each. Each car held 3 batch boxes, each holding an 8-bag batch, thus making the trains of 27 batches each. The batch boxes were of the old wooden type manufactured for the state in 1923.

**The Paver.**—The paver used on this work was a 32-E Koehring, equipped with a crane for handling the batch boxes. This machine was about 5 years old and had turned out about 60 miles of pavement prior to this job. A new Ord finisher was used on the work, and the remaining finishing was done as described on the preceding sections already described. The mixing time for the 1:2:3½ concrete was one minute, and enough water was used to give a slump of from one to one and one-half inches.

**Paving Crew.**—The paving crew consisted of one mixer operator, two hookers, one crane man, one finishing machine operator, 2 finishers, 3 spaders, one form man, two men on subgrade templates, one man on carrying and placing rods and doing similar work, one man oiling rods and forms and setting long rods, two men on curing, 4 men setting forms, and six men preparing finished subgrade.

It is interesting to note that all trucks and tractors used for the various purposes about the job, hauling supplies, and otherwise made use of were surplus war equipment.

**Those Responsible.**—This work was done by state forces under the direct supervision of H. B. Jay, superintendent of construction, and Louis Bowman, resident engineer, working under the direction of M. J. Flemming, district engineer. Frank T. Sheets, state highway engineer, is in general charge of all highway activities throughout the state, such as those described.

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**Peru's Three-Year Highway Program.**—It is proposed to have an annual allowance for highways of $1,200,000 for the years 1928, 1929 and 1930, set aside by the government from the Peruvian National Loan. In addition $800,000 for highway purposes has been appropriated by the government in the budget of the republic and is to be taken from its general revenues. The government will also use for this purpose revenues obtained from certain local imports specifically levied, conscript labor and the proceeds of exemptions from this service. Tolls have been created on certain roads and the revenues from this source will also be used in road building. With the above resources the government proposes to take care of the completion of 8,553 kilometers of new roads now under construction and to carry out this program within three years.

# The Cuban Central Highway, the Largest Single Road Contract Ever Awarded

Photos from Hamilton Wright

(1) Typical View of Country at Western End of Highway. (2) Placing in Concrete Base. (3) Throughout the Entire 700 Miles the Highway Is Lined Intermittently with These Royal Palms. (4) Difficult Excavation. (5) Completed Section East of Havana

WORK on the Central Highway of Cuba is ahead of its schedule at the present time and it is expected the 700 mile highway will be completed on or before June 30, 1930.

At the end of August, 1928, the length of highway completed with warrenite surface aggregated 194 kilometers, not in one continuous line, but distributed in five of the six Provinces. Most of the completed work, however, lies in Havana and Pinar del Rio Provinces. In Santa Clara Province no part of the highway has been finished. The entire line from Pinar del Rio to Santiago has been surveyed and about 90 per cent has been graded. It is estimated that about 60 per cent of the total necessary bridges have been built. Construction is being carried on simultaneously in all six provinces.

The road will be paved its full length. It is 20.66 ft. wide with 5.64 ft. shoulders. There will be 12 in. of crushed stone foundation, and a portland cement concrete base 6 in. in the center and 9 in. at the sides, and 2 in. of warrenite-bitulithic. On selected sections granite block pavement will be laid. The work calls for 3,648,196 cu. meters of earth excavation, 695,226 cu. meters of rock excavation, 5,562,927 cu. meters of embankment, 1,121,827 sq. meters of granite blocks, 5,562,927 meters of warrenite-bithulithic, 93,305 lin. meters of concrete curbing, 2,011,445 concrete headers, 28,551 lin. meters of concrete pipe and of materials 40,000,000 granite blocks, 1,700,000 cu. meters of crushed stone, 1,250,000 cu. meters of sand, 2,250,000 bbl. of portland cement, 60,000 tons of asphalt cement, 12,927,671 lb. of steel bars and 5,097 tons of steel bridges.

The Warren Brothers Co., of Boston, Mass., have the contract for constructing 500 miles of this highway, this being undoubtedly the largest single road contract ever awarded. The balance of the 200 miles is being handled by Cuban contractors.

# Detailed Bridge Construction Costs

## Typical Report as Kept on Job Shows General Data Collected

IN selecting a type of bridge to span a certain crossing there are several definite points to consider, each of which must receive its due amount of study. Each point must be measured with the ruler of its division. Generally, however, the final selection is one based on an economic analysis of the crossing. Mr. C. B. McCullough, bridge engineer for the Oregon State Highway Commission has gone into this subject very thoroughly in a book soon to be placed on the market entitled, "Economic Selection of Bridge Types."

The data which follows were abstracted from the original manuscript on this book and contains actual cost data taken by the state forces. Class A concrete was a nominal 1:2:4 mix requiring 6.3 sacks of cement per cubic yard. Table I is a compilation of seven typical bridge construction jobs recently finished and indicates the average range of costs for this class of work:

**Structural Steel.**—For ordinary truss construction, the average unit costs are indicated with reasonable accuracy by Table II from five typical construction jobs recently completed:

The above costs are for truss construction, plate girder work and rolled beams will probably erect for about 80 per cent of the above.

**Detailed Cost Reports.**—In order to illustrate the general scope of cost analysis reports which furnish the basis for data such as have been given hereinabove, it may be of interest to include two or three typical reports of this character.

Report No. 1 was submitted by Mr. Glenn S. Paxson, Assistant State Bridge Engineer and formerly general superintendent of bridge construction by state forces in Oregon. This report covers the construction of a short timber deck truss span and although the cost data refer to work done several years back the report is of value not only for indicating the general arrangement of data needed, but by substituting present prices and present wages these data are as good today as when taken. A radical departure in type of construction equipment is about the only thing that will render these figures invaluable. This report is as follows:

### Detailed Cost Report State Force Bridge Construction

**Bridge No. 537**

GENERAL DATA:

This bridge was built across Dry Creek, a small tributary of Crooked River about seven miles from Prineville on the Crooked River Highway. This creek is normally dry, except during the

**Table I.—Tabulation of Cost Analysis for Class A Concrete**

| Item | Job No.—A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| | Cost Per Cu. Yd. | | | | | | |
| Cement | $5.85 | $5.51 | $6.06 | $5.22 | $6.44 | $7.09 | $7.56 |
| Coarse aggregate | 2.02 | 2.53 | 2.13 | 2.08 | 3.38 | 2.75 | 1.41 |
| Fine aggregate | 1.60 | 1.96 | 1.22 | 1.27 | 1.80 | 1.27 | 0.81 |
| Forms and Falsework— | | | | | | | |
| Lumber | 2.38 | 1.83 | 2.41 | 2.06 | 1.48 | 1.52 | 2.69 |
| Hardware | 0.14 | 0.24 | 0.23 | 0.48 | 0.11 | 0.10 | 0.30 |
| Labor | 7.47 | 2.39 | 4.00 | 5.98 | 4.53 | 3.18 | 6.75 |
| Mixing and placing | 3.08 | 2.37 | 3.45 | 1.55 | 4.69 | 1.21 | 3.43 |
| Finishing | 0.72 | 3.17 | 1.03 | 1.09 | 0.71 | 0.17 | 0.60 |
| Equipment charges | 0.75 | 0.97 | 0.59 | 1.92 | 3.47 | 1.72 | ..... |
| Total cost per cu. yd. | $24.01 | $20.97 | $21.13 | $21.65 | $26.61 | $19.21 | $23.55 |
| Yardage placed | 346 | 124 | 532 | 1,141 | 146 | 426 | 319 |
| Labor costs in man-hours per cu. yd.— | | | | | | | |
| Forms and falsework | ..... | $3.83 | $7.35 | $10.14 | $5.94 | ..... | ..... |
| Mixing and placing | ..... | 4.00 | 6.69 | 3.12 | 7.23 | ..... | ..... |
| Finishing | ..... | ..... | 2.01 | 1.92 | 0.90 | ..... | ..... |
| Cost of forms and falsework per sq. ft. surface of concrete— | | | | | | | |
| Lumber | $0.053 | $0.024 | $0.060 | $0.060 | ..... | ..... | ..... |
| Hardware | .003 | .003 | .006 | .010 | ..... | ..... | ..... |
| Labor | .173 | .031 | .110 | .160 | ..... | ..... | ..... |
| Cost of finishing per sq. ft. of surface— | | | | | | | |
| Finishing | $0.016 | $0.086* | $0.030 | $0.030 | ..... | ..... | ..... |

*This cost is for special plaster finish and includes cost of special white sand and white cement. Labor cost alone amounts to $0.05 per square foot.

**Table II—Tabulation of Cost Analyses—Structural Steel in Place—Ordinary Highway Bridge Trusses**

| Item | Job No. A | B | C | D | E |
|---|---|---|---|---|---|
| | Unit Cost Per Pound | | | | |
| Material F.O.B. job | $0.06000 | $0.05025 | $0.05500 | $0.05900 | $0.05600 |
| Falsework material | .00400 | .00043 | .00180 | .00200 | .00400 |
| Labor on falsework | .00200 | .00090 | .00300 | .00110 | .00100 |
| Erecting | .00400 | .01104 | .00360 | .00560 | .00300 |
| Riveting | .00400 | .00788 | .00580 | .00580 | .00500 |
| Field painting | | | | | |
| Material | .00100 | .00078 | .00090 | .00080 | .00100 |
| Labor | .00100 | .00136 | .00150 | .00160 | .00200 |
| Equipment charges | .00100 | .00231 | ..... | ..... | .01000 |
| Total cost per pound erected | $0.07700 | $0.07495 | $0.07160 | $0.07590 | $0.08200 |

**Table III—Detailed Cost of Bridges Built by State Force Account**

I—GENERAL EQUIPMENT COSTS

| | | |
|---|---|---|
| Inventory value of equipment transferred to this bridge | | $237.10 |
| Equipment purchased | | 45.03 |
| Rentals paid out for equipment rented | | 30.00 |
| Total | | 312.13 |
| Less inventory value of equipment transferred from this bridge at end of job | | 218.75 |
| Net general equipment charge | | $93.38 |

II—ENGINEERING, SUPERVISION AND MISCELLANEOUS OVERHEAD EXPENSE

| | | |
|---|---|---|
| Expense, Ford touring car No. 40 | | $114.23 |
| Expense, Ford touring car No. 46 | | 101.94 |
| Salary of superintendent | | 304.37 |
| Truck No. 59 transporting men to and from work | | 95.10 |
| Miscellaneous minor expense items | | 118.84 |
| Total cost of eng'r. super., etc. | | $734.48 |
| Total equipment plus overhead (I and II) | | $827.86 |
| Distribution of items I and II | | |
| Excavation | $134.16 | |
| Concrete (Class B) | 225.21 | |
| Steel reinforcing | 18.13 | |
| Trestle approach | 145.13 | |
| Truss span | 305.23 | |
| | $827.86 | |

III—EXCAVATION

| | | |
|---|---|---|
| Labor, 1,057 man-hours | | $634.45 |
| Rental on pump and engine | | 11.25 |
| Repairs to pump and engine | | 15.78 |
| Gas—15 gals. at 33⅓c | | 5.03 |
| Supplies | | 11.60 |
| Miscellaneous (see distribution under II) | | 134.16 |
| Total cost of excavation | | $812.27 |
| Yardage moved 100 cu. yds. | | |
| Unit cost per cu. yd., $8.12. | | |

IV—CLASS B CONCRETE (Piers)

| | | |
|---|---|---|
| (1) Sand and gravel | | |
| Building road to gravel bar—20 man-hours | | $ 13.50 |
| Screening sand and gravel, 278 man-hours | | 173.26 |
| Hauling sand and gravel, 140 team-hours | | 120.50 |
| Total | | $307.26 |

break up in the spring when melting snow brings down from 4 to 8 ft. of water. The territory drained is subject to cloud bursts during May and June which have resulted in flood waters higher than the normal spring flow. The foundations for the piers were placed 4 ft. below stream bed and rested upon gravel mixed with large boulders. The excavation was begun before the spring break up and completed after the surface water had run off. A large flow of water was encountered about two feet below the surface. Considerable trouble was experienced with pumping equipment which ran the excavation costs rather high. The material handled was difficult. All of it had to be picked and a large number of boulders were found that had to be broken up before they could be removed. There was a total of 100 cu. yds. moved in 1,057 man-hours or 10.57 man-hours per cu. yd. This includes the time spent repairing and operating the pump.

Sand and gravel from a bar in Crooked River two miles from the bridge was used. It was screened and reproportioned before mixing. The sand and gravel was hauled by team. The labor of screening and loading amounted to 278 man-hours or 3.47 man-hours per cu. yd. for the 80 cu. yds. used. It was hauled in 140 team-hours or 1.75 team-hours per cu. yd.

The forms for the barrels of the piers were cut at a mill in Prineville and were assembled outside the excavation and then set in place. The labor on the forms amounted to 195 man-hours or 3.55 man-hours per cu. yd. for the 55.03 cu. yds. of concrete placed.

A large steam paving mixer belonging to the Highway Department was used, owing to the fact that no other equipment was available at the time. Due to its excessive weight and to the condition of the roads, the cost of getting this mixer onto the job and setting it up was high. The mixing and placing was done in 196 man-hours or 3.56 man-hours per cu. yd.

There was one 19 foot approach bent on each end of the truss. The total lumber in these two bents amounted to 8,139 F.B.M. It was framed in 64 man-hours or 7.86 man-hours per M.B.M. It was erected in 204 man-hours or 25.06 man-hours per M.B.M. The painting took 20 man-hours.

The truss was a 40-foot pony span with the deck superelevated 6 inches for a nine degree curve. The total lumber in the truss was 11,045 F.B.M. This was framed in 153 man-hours or 13.85 man-hours per M.B.M. The truss was erected in 357 man-hours or 32.32 man-hours per M.B.M. The painting was done in 82 man-hours.

Very little false work was needed for this short a span. One bent was erected at the center of the truss. The bottom chords were placed and the deck laid before the remainder of the truss was put up. As the floor beams set on top of the chord, the deck came high enough

**Table III—Continued**

Unit cost per cu. yd of gravel and sand, $3.84.
Unit cost per cu. yd. of concrete placed, 5.58.

| | | | |
|---|---|---|---|
| (2) Cement | | | |
| 55 bbls. at $3.00 F.O.B. Gold Hill | | $165.00 | |
| Freight 55 bbls. at $1.94 per bbl | | 106.70 | |
| Hauling, $0.40 per ton per mile | | 27.20 | |
| Total cost cement | | | $298.90 |
| 55.03 cu. yds. concrete poured, unit cost per bbl., $5.43. | | | |
| Unit cost per cu. yd. of concrete placed, $5.43. | | | |
| (3) Forms | | | |
| Lumber 513 F.B.M. at $33.75 | $17.31 | | |
| 1,664 F.B.M. at 31.50 | 52.42 | | |
| 1,477 F.B.M. at 27.00 | 39.88 | | |
| 600 F.B.M. at 25.20 | 15.12 | | |
| | $124.73 | $124.73 | |
| Hauling 4,254 F.B.M. at $0.50 per M per mile | | 17.20 | |
| Nails | | .90 | |
| Labor, 195 man-hours | | 157.52 | |
| 5 hours band-saw work at $3.00 | | 15.00 | |
| Total cost forms | | | $315.17 |
| 55.03 cu. yds. concrete poured, unit cost per cu. yd. of concrete placed, $5.73. | | | |
| (4) Mixing and Placing | | | |
| Rental on pump and engine | | $ 13.25 | |
| Pipe fittings | | 1.60 | |
| Labor, 196 man-hours | | 104.79 | |
| Total cost mixing and placing | | | $119.64 |
| 55.03 cu. yds. concrete poured, unit cost per cu. yd. concrete placed, $2.17. | | | |
| (5) Concrete plants | | | |
| Hauling mixer to job | | $ 32.37 | |
| Supplies | | 10.31 | |
| Labor setting up runways, etc., 74 man-hours | | 46.49 | |
| Total cost concrete plant | | | $89.17 |
| 55.03 cu. yds. poured, unit cost per cu. yd. of concrete placed, $1.62. | | | |
| (6) Finishing concrete | | | |
| Labor, 16 man-hours | | $ 8.00 | |
| Total cost finishing concrete | | | $8.00 |
| 55.03 cu. yds. concrete poured, unit cost per cu. yd. of concrete placed, $0.14. | | | |
| (7) Miscellaneous | | | |
| (See distribution of equipment, overhead, etc., above) | | | $225.21 |
| 55.03 cu. yds. concrete poured, unit cost per cu. yd. of concrete placed, $4.09. | | | |
| | | | $1,363.35 |

**Total unit cost for concrte $24.78.**

| | | |
|---|---|---|
| V—REINFORCING STEEL | | |
| 807 lb. ½ in. sq. at .056 per lb | $45.19 | |
| 443 lb. 1 in. sq. at .055 per lb | 24.36 | |
| Freight | 11.81 | |
| Hauling, at $0.40 per ton per mile | 4.26 | |
| Placing, 8 man-hours | 6.00 | |
| Miscellaneous (see distribution under II above) | 18.13 | |
| Total cost reinforcing steel | | $109.75 |
| 1,250 lb. placed. Unit cost per lb., $0.088. | | |
| VI—TRESTLE | | |
| (1) 8,139 F.B.M. Lumber at $41.00 per M. | $333.70 | |
| Freight | 110.23 | |
| Hauling at $0.50 per M per mile | 45.05 | |
| Total | | $488.93 |
| 8,139 F.B.M., unit cost per M at site, $60.08. | | |
| (2) Paint and carbolineum | $ 9.00 | |
| Freight | 3.16 | |
| Brushes | 1.50 | |
| Total | | $13.66 |
| 8,139 F.B.M., unit cost per M, $1.68. | | |
| (3) Labor: | | |
| Framing, 64 man-hours | $ 48.00 | |
| Erecting, 204 man-hours | 144.75 | |
| Painting, 20 man-hours | 9.50 | |
| Total | | $202.25 |
| 8,139 F.B.M., unit cost per M, $24.85. | | |
| (4) Other costs | | |
| Tool house | $ 14.48 | |
| Bolts | 2.95 | |
| Miscellaneous (see distribution under II above) | 145.13 | |
| Total | | $162.56 |
| 8,139 F.B.M., unit cost per M, $19.96. | | |
| Total cost Trestle | | $867.45 |
| 8,139 F.B.M., 38 lin. ft. | | |
| Total unit cost per M.B.M. | $106.58 | |
| Total unit cost per lin. ft. trestle | 22.89 | |
| VII—APPROACH BACK FILL | | |
| Labor, 32 team hours, 12 man-hours | $30.00 | |
| Total | | $30.00 |
| 65 cu. yds. moved, unit cost per cu. yd., $0.46. | | |
| VIII—TRUSS | | |
| (1) Steel | | |
| 3,150 lbs. at $11.90 per cwt | $374.90 | |
| Freight | 8.17 | |
| Hauling at $0.40 per ton per mile | 3.12 | |
| Total | | $386.19 |

Table III—Continued

3,150 lbs., unit cost per cwt., $12.26.

| | | |
|---|---|---|
| (2) Lumber | | |
| 11,045 F.B.M. at $41.00 per M | $453.25 | |
| Freight | 149.41 | |
| Hauling at $0.50 per M per mile | 75.63 | |
| Unloading at Prineville, 29 man-hours | 18.38 | |
| Total | | $696.67 |
| 11,045 F.B.M., unit cost per M at bridge, $63.08. | | |
| (3) Paint and carbolineum | $ 9.15 | |
| Freight | 3.16 | |
| Total | | $12.31 |
| 11,045 F.B.M., unit cost per M, $1.12. | | |
| (4) Labor | | |
| Framing, 153 man-hours | $132.00 | |
| Erecting, 357 man-hours | 264.45 | |
| Painting, 82 man-hours | 42.50 | |
| Falsework, 14 man-hours | 8.12 | |
| Total | | $447.07 |
| 11,045 F.B.M., unit cost per M, $40.47. | | |
| (5) Other costs | | |
| Tool house | $ 30.44 | |
| Framing yard 45 man-hours | 25.75 | |
| Miscellaneous (see distribution under II above) | 305.23 | |
| Total | | $361.42 |
| 11,045 F.B.M., unit cost per M, $32.72. | | |
| Total cost of lumber in place, $137.39 per M. | | |
| Total cost of truss (including steel) | | $1,903.66 |

RECAPITULATION OF COSTS

| | Unit | Quant. | Cost per unit | Total Cost | Total cost per unit | Total Cost |
|---|---|---|---|---|---|---|
| (1) Excavation | C.Y. | 100 | | | $ 8.12 | $ 812.27 |
| (2) Concrete | C.Y. | 55.03 | | | 24.78 | 1,363.35 |
| (a) Sand and gravel | C.Y. | 80 | $ 3.84 | $ 307.26 | | |
| | C.Y. | 55.03 | 5.58 | | | |
| (b) Cement | Bbl. | 55 | 5.43 | 298.90 | | |
| | C.Y. | 55.03 | 5.43 | | | |
| (c) Mixing and placing | C.Y. | 55.03 | 2.17 | 119.64 | | |
| (d) Forms | C.Y. | 55.03 | 5.73 | 315.17 | | |
| (e) Concrete plant | C.Y. | 55.03 | 1.62 | 89.17 | | |
| (f) Finishing | C.Y. | 55.03 | .14 | 8.00 | | |
| (g) Miscellaneous | C.Y. | 55.03 | 4.09 | 225.21 | | |
| (3) Reinforcing Steel | lb. | 1,250 | | | 0.088 | 109.75 |
| (a) F.O.B. Portland | lb. | 1,250 | .0557 | 69.55 | | |
| (b) Freight and hauling | lb. | 1,250 | .0129 | 16.07 | | |
| (c) Placing | lb. | 1,250 | .0048 | 6.00 | | |
| (d) Miscellaneous | lb. | 1,250 | .0146 | 18.13 | | |
| (4) Approach back fill | | | | | | |
| (a) Labor | C.Y. | 65 | | | .46 | 30.00 |
| (5) Trestle | M.B.M. | 8.139 | | | 106.58 | 867.45 |
| | Lin. ft. | 38 | | | 22.89 | |
| (a) Lumber | M.B.M. | 8.139 | 60.08 | 488.98 | | |
| (b) Paint and carbolineum | M.B.M. | 8.139 | 1.68 | 13.66 | | |
| (c) Labor | M.B.M. | 8.139 | 24.85 | 202.25 | | |
| (d) Miscellaneous | M.B.M. | 8.139 | 19.97 | 162.56 | | |
| (6) Truss | | | | | 1,903.66 | 1,903.66 |
| (a) Steel | Cwt. | 31.5 | 12.26 | 386.19 | | |
| (b) Lumber | M.B.M. | 11.045 | 63.08 | 696.67 | | |
| (c) Paint and carbolineum | M.B.M. | 11.045 | 1.12 | 12.31 | | |
| (d) Labor | M.B.M. | 11.045 | 40.47 | 447.07 | | |
| (e) Miscellaneous | M.B.M. | 11.045 | 32.72 | 361.42 | | |
| Total cost of lumber in place | M.B.M. | 11.045 | 137.39 | 1,517.97 | | |
| TOTAL COST OF BRIDGE | | | | | | $5,086.48 |

to allow working on the truss without scaffolding. Some trouble was encountered with the superelevation shims for the truss. These were sent out from the mill as 10 x 12s, each stick to make two shims. The cost of ripping these timbers by hand with the equipment on the job would have been high, for which reason these shims were taken to a small mill near Prineville and cut there.

The materials for the bridge were hauled by contract. The price on lumber being $0.50 per M.B.M. per mile and on cement and steel $0.40 per ton per mile.

The contractor doing the grading on the Crooked River Highway had completed his work before the bridge was commenced and the approach back fill was made by day labor. About 65 cu. yds. of material were used at a cost of $0.46 per cu. yd.

Construction was begun on January 18th but had to shut down February 18th on account of high water in Dry Creek. Work began again April 4th and the bridge was completed May 5th. The wages paid were $4.50 for laborers and $7.00 for carpenters up to April 1st and $3.50 and $4.00 for laborers and $6.00 for carpenters after that time. Teams with drivers received $6.00 per day.

The detailed costs are given in Table III.

## Accidents at Highway Grade Crossings

During the past ten years, 20,427 persons have been killed and 57,625 seriously injured in highway grade crossing accidents on major steam railroads. The figures do not include grade crossing accidents occurring on smaller steam railroads or on electric and oil lines.

These figures were made public by the American Road Builders' Association as part of its national highway safety campaign. The association points out that while the number of fatalities has increased steadily since 1918, the comparative number of deaths has been decreased. In 1918 a total of 1,852 persons were killed in these accidents as compared with 2,371 in 1927. In 1927 there were .94 persons killed per 10,000 motor vehicles as compared with 1.84 persons in 1918.

The decrease in highway grade crossing fatalities has been the result of educational measures taken by railroads and cooperating organizations, the American Road Builders' Association declares. "A continued reduction is dependent upon the practice of caution on the part of motor vehicle drivers. Courtesy and caution are the two fundamentals which will eventually bring a noteworthy decrease in all types of highway accidents.

"The two major factors which will contribute toward better conditions at the railroad grade crossings are crossing elimination and individual education. There are approximately 207,000 unprotected grade crossings on major steam railroads alone. It is economically impossible for the complete elimination of these crossings within the very near future. It is possible however, to eliminate the more dangerous crossings and at the same time continue the education of the motoring public in the value of courtesy and caution when approaching these hazards.

"It is a regrettable fact," the American Road Builders' Association continues, "that 238 persons were killed at grade crossings last year as a result of running into the side of moving trains. This demonstrates the gross negligence on the part of some drivers when approaching dangerous crossings. Most inexcusable deaths result from attempts to beat trains to a crossing or approaching at a high speed where the view is obstructed in some degree.

The association urged highway departments and railroads to continue the elimination of grade crossings as fast as economic conditions permit.

"More important," the association adds, "is the practice of the simple code of courtesy and caution on the part of every individual. The engineer of a steam locomotive is virtually powerless to avert an accident when a motor car obstructs the right-of-way. The avoidance of accidents is the duty of the driver of the motor car."

In summarizing grade crossing conditions on major steam railroads, the American Road Builders' Association stated that at the beginning of 1927, there were 206,533 unprotected crossings in the United States. 6,148 crossings were protected by gates, 7,760 were guarded by watchmen, 6,421 had both audible and visible signals, 5,308 were guarded by audible signals only, and 2,204 had visible signals only. Of the 235,138 grade crossings in the United States, only 27,747 had any kind of protection.

The above figures do not include crossings located on electric, gas or oil railroads, or on steam railroads of second, third and fourth grades.

# Turn-Over Method of Road Treatment

## Methods and Costs on Two New Mexico Jobs

By E. B. BAIL

Construction and Maintenance Engineer, Highway Commission of New Mexico

EARLY in the summer of 1927 the New Mexico Highway Commission decided to investigate the mix-in-place or "turn-over" method of treating crushed rock and gravel roads with asphaltic oils. The Commission decided that the first trial of the "turn-over" process should be on the Los Lunas-Isleta road, a state highway, not on the Federal Aid System, but at present carrying the traffic of both Highway 85 and Highway 66 between Isleta and Los Lunas.

This road has reasonably good alignment but is entirely too narrow for the traffic it has to carry. The grade is not sufficiently high to insure that the sub-grade will be dry at all times and in some places is lower than the adjacent farm lands. During December, January and February a rising water table added to a reckless and indiscriminate use of irrigation water combine to form a most unsatisfactory condition for sub-grade stability.

This condition does not prevail during the summer months, and much of the expected trouble may be avoided during the months above mentioned if only the property owners fronting the road will be restrained by an appreciation of the certain unfavorable effects on the road of a continuation of the policy—or, rather, lack of policy—governing the use of irrigation water in the past.

**Preliminary Operations.**—In preparation for the oiling the road was widened with tractors and graders. This was a stiff job and, unfortunately, grader men equal to the work were not available. After the widening work the road was still too narrow.

The Highway Department then let a contract to Rawles & Wright for Valencia County for the surfacing of the road. The material applied was of good quality and sufficiently well graded for the application of oil. The gravel was applied in varying thicknesses from a minimum of 6 in. up to 12 in. over the sections where subgrade failure might be expected.

Preliminary work ahead of oiling began about May 20, when scarifying operations were started. The gravel was cut to a depth of 3 in. over a width of 18 ft. It was not hard work, unfortunately, because of the fact that there had not been sufficient rain on the road since the placing of the gravel to secure even a moderate compaction. About 12 ft. of the roadway was fairly firm. The shoulders were soft.

**Oiling Operations.**—The first application of oil was made June 4 and the job was completed June 29. The gross length of job was 11.6 miles; the net length was 11.2, there being two bridges on the job which were not oiled.

The Gilmore Oil Co. of Los Angeles furnished the distributor and the operators for same.

The work may be roughly divided into five operations; these with their costs for this job, follow:

| | | |
|---|---|---|
| 1. | Scarifying | $ 691.32 |
| 2. | Disc-harrowing | 383.58 |
| 3. | Heating oil | 429.43 |
| 4. | Processing | 1,436.50 |
| 5. | Shaping Under Traffic | 384.92 |

One hundred thousand, four hundred and nineteen gallons of oil were used on 118,272 sq. yd. of road, making the unit application 1.331 gal. per square yard. The cost of the oil was $0.07066 per gallon applied on the road. The total cost for labor, supplies, oil, and equipment rental was $1,427.57 per mile.

Considering the fact that a green crew did the work, the above costs are pleasingly low. They are, in fact, about $375 per mile lower than the writer's lowest estimate for this work and $575 per mile lower than the top price estimated.

As on every other construction job there is a reason. The reason in this case is the man directly in charge of the work. C. C. Cash has been just a little more than 99 per cent of the job and the writer's hat is off to him. It takes energy and ability to get a good job and low costs, both of which have been accomplished on this road. Troy Robertson, who was assigned to the work from District No. 2, has proven a very capable man and of great assistance to Mr. Cash. Should it be deemed advisable to put a second outfit in the field, it is likely that Mr. Robertson will be placed in charge of the second crew.

**Federal Aid Project No. 136.**—An investigation of this project early this spring disclosed that only 3 in. of wearing surface was left. It was believed that further delay in bringing this job up to standard would involve heavy and practically useless maintenance and a complete resurfacing of the job next spring.

An agreement was tentatively entered into with the Bureau of Public Roads whereby the State agreed to put on 3 in. of selected material, after which the Bureau would participate in the cost of oiling. However, there being a shortage of Federal funds for construction, the State withdrew its request for financial aid from the Government. The selected material was taken from the sides of a cut along the road. It was fairly uniform in grading about 80 per cent passing the ½-in. screen and roughly 60 per cent passing the 10-mesh. It took a full 1½ gal. of oil to the square yard.

On F. A. P. No. 136 conditions were much more favorable than on the Isleta-Los Lunas road. The road is 24 ft. wide with a well compacted surface over 18 ft. It should give excellent service.

It may be noted in passing that this project had cost the State, prior to oiling, $1,125 per mile in lost material and maintenance charges since it was completed in the late winter of 1925.

**Oiling Costs of F. A. P. No. 136**

| | Total Cost | Cost Per Mile |
|---|---|---|
| Disc Harrowing | $ 150.26 | $ 75.13 |
| Heating Oil | 6.13 | 3.07 |
| Processing | 310.52 | 155.26 |
| Shaping Under Traffic | 137.97 | 68.99 |
| Oil | 2,244.66 | 1,122.33 |
| Equipment Rental | 252.00 | 126.00 |
| Total | $3,101.54 | $1,550.78 |

**Conclusions.**—Scarifying was not required on this job. Beyond stating that the treated roads have come up to expectations the writer has no comment to make.

Summing up briefly: The "turn-over" process is a fairly efficient, and, in the hands of competent men, a reasonably cheap method of conserving our gravel roads and making travel over them more a pleasure than a purely sporting proposition.

**Acknowledgment.**—The foregoing is abstracted from the August New Mexico Highway Journal.

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# Buenos Aires, Argentina, Provincial Highway Law

A provincial law for providing a permanent highway fund was before the Buenos Aires Provincial Legislature on Oct 31, 1927, when it adjourned. The law had been approved in the Chamber of Deputies, but failed to receive action in the Senate before adjournment, according to a report from Automotive Trade Commissioner Howard W. Tackebury, Buenos Aires, released by the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce. This law provides for the building and maintenance of some 11,000 kilometers of roads throughout the Province, at a cost 600,000,000 pesos (approximately $258,000,000 at current rates of exchange). The law provides for the emission of bonds up to 20,000,000 pesos per for this work, each series to be amortized within a period of thirty years.

On July 31, 1928, the Senate of the Province of Buenos Aires approved the law in principal, and on August 7 it was approved in detail. A few minor changes in the law were made at this time. Because of the changes which have been made, the law must now be referred back to the Chamber of Deputies for approval.

It is generally considered that the modified law will receive the prompt approval of the Chamber of Deputies without further change, since all of the changes made in the Senate were of minor importance.

If this law is passed, as now seems certain, it will be by far the most important and comprehensive highway program of Argentina, from either the national or provincial standpoint.

# Design of Pavement Concrete bv Water-Cement Ratio Method

## A Suggested Method Described in the August Public Roads

By F. H. JACKSON

Senior Engineer of Tests, Division of Tests, U. S. Bureau of Public Roads

THE present method of specifying arbitrary proportions of cement, sand, and coarse aggregate for concrete, even though it may in most instances provide a satisfactory job from the standpoint of quality, is at best unsound from an economic point of view. This is true because in order to insure concrete of the designed strength under conditions which involve the possible use of a variety of materials it is necessary, when using fixed proportions, to adjust them on the basis of the most unfavorable combination possible under the specification. This is, of course, on the assumption that within the usual specification limits variations in such factors as character and grading of aggregates and quality of cement appreciably affect the quality of the concrete.

The investigation by the Bureau of Public Roads in cooperation with the New Jersey State Highway Commission,[1] as well as the tests now under way at Arlington, indicate that, in so far as character of aggregate is concerned, such variations may influence to a marked degree the transverse and tensile strength of the concrete, even though the crushing strength may be but slightly affected. Investigations conducted by the bureau in cooperation with the American Association of State Highway Officials indicate clearly that variations in the physical properties of Portland cements, all meeting the American Society for Testing Materials specifications, may quite appreciably affect the strength of the concrete.

From the standpoint of yield, also, it is well known that, under the present system of proportioning, variations in yield will occur, due to both type and gradation of aggregates. Such variations lead to fluctuations in the cement factor which are frequently the cause of misunderstandings and arguments between engineers and contractors. From many standpoints it seems desirable to so modify our procedure as to take advantage of such variations in aggregates and cement as normally occur in a given locality, as to produce concrete of the required strength at a minimum cost, and at the same time to provide such methods of handling and measuring the materials as will insure the production of fixed and uniform quantities of concrete. In this paper an attempt will be made to develop such a method by utilizing the well-established water-cement ratio law, and at the same time taking into consideration the various factors which render it impossible to make a general application of that law, as has been attempted by some authorities in the past.

The suggested method of design has already been tried with success on building construction, and no originality is claimed by the writer. This method will be developed, together with a discussion of changes in methods of securing bids on concrete-paving projects, which, it is believed, will be necessary this relation when plotted takes a form in order to make the suggested scheme of design effective.

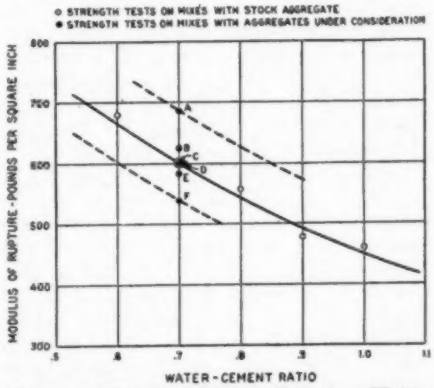


**Fig. 1.—Typical Relation Between Water-Cement Ratio and Flexual Strength of Concrete at 28 Days**

**Water-Cement Ratio Theory Discussed.**—It is now almost universally recognized that there is a well-defined relation between the strength of concrete and the water-cement ratio for any given combination of materials. Many tests have also indicated that which may be expressed by the general equation $S = \frac{A}{B^x}$. This is the general form of the well-known formula derived by Abrams.[2] Values for $A$ and $B$ depend upon the particular combination of materials used, as well as the character of the stress being investigated. $S$ represents the strength of the concrete at 28 days and $x$ an exponent, the water-cement ratio. To use the formula it is necessary to determine the constants for the particular materials being investigated, which, of course, must be done experimentally by testing a series of concrete specimens made with various water-cement ratios and plotting the strengths obtained against the corresponding ratios.

Before proceeding to a discussion of the principles governing the proposed method of designing concrete it may be well to state that, because of the experimental work involved, it will be necessary in the application of this method to have available a well-equipped laboratory with a qualified concrete testing engineer in charge. The designing of a concrete mixture to be used in a structure which is guaranteed to meet certain requirements as to strength, durability, etc., is just as much a technical operation requiring the services of a trained personnel as is the designing of the structure itself.

Furthermore, all attempts which have been made to design concrete through the application of certain formulas based only on considerations of grading of aggregates, such as fineness modulus, grading factor, surface area, etc., have failed, at least in so far as concrete for pavements is concerned, in one important respect—they do not take into account the character of the aggregates employed. By character is meant not only type—that is, crushed stone, gravel, etc.—but such factors as surface texture, angularity of fragments, etc. These factors affect the quality of the concrete in two ways—first, by influencing workability, which in turn controls the ratio of fine to coarse aggregate as well as the relative water content and, second, through the adhesion or bond which is produced between the cement and the aggregate surfaces.

The effects of such factors are particularly noticeable when the concrete is subjected to tensile and flexural stresses and are therefore of importance to the highway engineer. They apply alike to fine and coarse aggregates and explain why the experimental or trial method of design must be used. In other words, we have not yet reached the point where we can entirely discard actual tests of trial mixtures in favor of mathematical formulas in the design of concrete mixtures.

There are, however, certain fundamental principles underlying all methods of concrete design which must be

[1] Jackson, F. H., Comparative Tests of Crushed-Stone and Gravel Concrete in New Jersey, Public Roads, vol. 8, No. 12, February, 1928.

[2] Abrams, D. A., Design of Concrete Mixtures, Bull. 1, Structural Materials Research Laboratory, Lewis Institute, Chicago, Ill.

thoroughly understood by everyone who intends to use the so-called trial method, and these will be discussed briefly before giving the various steps in the suggested method.

**Method of Determining Ratio of Fine to Coarse Aggregate Described.**—The first question to decide is the proper ratio in which to combine the various fine and coarse aggregates which are available for a given job, giving in each case due consideration to both workability and economy. There are four general rules which may be applied to this particular problem, as follows:

(1) The proportion of sand should be increased as the sand becomes coarser.

(2) The proportion of sand should be increased as the maximum size of the coarse aggregate becomes smaller.

(3) The proportion of sand should be increased as the percentage of fine material in the coarse aggregate becomes smaller.

(4) The proportion of sand should be increased as the percentage of angular fragments in the coarse aggregate becomes larger.

These principles are well known. The average specification for concrete, however, recognizes them only in a general way, usually by a clause giving the engineer the power to slightly change the proportion of fine to coarse aggregate to secure maximum density. It should be possible in designing the mix to fix this ratio much more accurately than is possible under the present arbitrary method. The most important point to remember is that a balance will have to be struck between a high sanded mix, which, although workable, is apt to be uneconomical, due to the fact that, for a constant water-cement ratio, more cement will be required for a given consistency, and a low sanded mix, which, although economical in so far as cement content is concerned, is apt to give trouble in placing.

In the writer's opinion the ideal combination is the one in which the voids in the coarse aggregate are maintained at a minimum, so as to permit the use of the smallest amount of mortar possible and still have a workable mix. In order to do this, the grading of the coarse aggregate must be controlled very carefully throughout the entire job, and this can best be done by handling and measuring it in separate sizes. This method serves also to eliminate segregation, and thus makes possible the use of a larger maximum size of coarse aggregate, which is economical from the standpoint of cement required. In the case of crushed stone the use of a larger size involves less crushing and is therefore more economical. Too little attention has been paid to such details in the past with the result that, although most of our concrete may be, and probably is, of satisfactory quality, it has not been designed so as to make the best use of a closely controlled coarse aggregate grading, which is the only way maximum workability can be attained with a minimum of cement. Just how far we can go in any particular case will depend, of course, upon the materials available, methods of finishing to be employed, etc. In general, there is no reason for using more mortar than is necessary to secure the proper finish. Under such a condition it will usually be found that there is enough mortar present to fill the voids in the coarse aggregate with a slight excess, and it is believed that, under our modern methods of finishing, this will prove sufficient in practically all cases to secure a dense, homogeneous concrete free from honeycomb.

For the usual run of materials for concrete roads the proper ratio of the volume of fine to coarse aggregate will range from a 30:70 ratio for a relatively fine sand combined with a closely graded easy-working coarse aggregate to a 40:60 ratio for a coarse sand combined with a high-void, harsh-working coarse aggregate. As previously stated, effort should be made when studying various possible combinations to keep as near the former ratio as possible, for the sake of economy, always remembering that the final value to use will depend entirely upon whether it is possible to secure a satisfactory finish and a concrete free from honeycomb with the placing and finishing equipment to be used on the job.

Using modern methods of handling it is believed that this condition can be attained frequently with a lower sand content than was possible with the old hand-finishing methods. As far as this factor is concerned, it is necessary to fall back upon judgment backed by actual observations on the job, rather than to rely entirely upon set formulas, helpful as they may be in giving preliminary indications.

As a guide, however, in making such a preliminary estimate of the proper ratio to use in any specific case, the values given in Table I may be taken. In general, these ratios are about the same as would be obtained by the use of the fineness modulus method suggested by the Portland Cement Association,[3] except that in no case is the percentage of fine aggregate less than 25 or more than 45 per cent of the sum of the volumes of the fine and coarse aggregate measured separately. It will be observed that these values illustrate the principles governing the proper ratio of fine to coarse aggregate given above. The values given in the table do not represent necessarily the final ratios to use. The best final values in any case can only be determined by trial, bearing in mind that the smallest amount of sand consistent with workability should ordinarily be used.

**Table I.—Approximate Ratios, by Volume, of Fine to Coarse Aggregate for Paving Concrete, Machine Finished**

| Coarse Aggregate—Size Limits | Fine Aggregate—Size Limits | | | |
|---|---|---|---|---|
| | 0-No. 16 | 0-No. 8 | 0-No. 4 | 0-⅜-in. |
| No. 4 to ¾-in. | 35:65 | 37:63 | 40:60 | 45:55 |
| No. 4 to 1-in. | 30:70 | 32:68 | 35:65 | 40:60 |
| No. 4 to 2-in. | 25:75 | 27:73 | 30:70 | 35:65 |

Notes.—The above values are based on the use of the usual type of natural sand combined with a coarse aggregate consisting essentially of rounded fragments. With coarse aggregate consisting essentially of angular fragments it may be necessary to increase the percentage of sand slightly over the values above given.

It has been assumed that the concrete will be machine finished. For hand-finished work the percentage of sand may have to be increased somewhat.

For an aggregate to be given a certain maximum size, at least 15 per cent must be retained on the next smaller sieve shown in the table. For instance, a sand having 16 per cent retained on a No. 8 sieve is classed as a 0-No. 4 sand. For a sand to be classed as a 0-No. 16 sand, at least 15 per cent must be retained on a No. 30 sieve.

All coarse aggregates are assumed to be reasonably well graded from the maximum size to No. 4, with not more than 15 per cent passing the No. 4 sieve.

The use of a 0-No. 16 sand is not recommended, except under conditions where a coarser sand is not available, on account of the fact that concrete in which a fine sand is used is in general not quite so resistant to wear as when a coarse sand is used.

**Determination of Proportions Based on Laboratory Tests.**—Having tentatively fixed the proper ratio of fine to coarse aggregate for each available combination, the next step is to determine in each case how much cement and water to use to secure concrete meeting the requirements of the specification. For purposes of discussion it will be assumed that a minimum flexural strength (modulus of rupture) is specified. It is recognized that strength is not the only criterion upon which to judge the quality of concrete. Durability and resistance to wear are of great importance. However, it must be confessed that at present we are able to talk only in generalities with regard to durability. We have no definite requirements which may be set up in specifications. About all that we can do, assuming that the aggregates themselves possess the necessary properties as regards durability and resistance to wear, is to assume that concrete which will meet the strength requirements and which is sufficiently workable to be placed and finished in a satisfactory manner will be as permanent as it is possible to make it with our present knowledge of the art.

It will be assumed that the specifications call for a concrete which when tested under standard laboratory conditions will have a certain modulus of rupture, say 600 pounds per square inch at 28 days. The problem is to determine the most economical mixture which will give this strength and at the same time be sufficiently workable to place and finish properly on the job. Unfortunately at the present time it is impractical to attempt to control the quality of the cement to be used on the job further than to require that it pass the American Society for Testing Materials requirements. In trial determinations, therefore, it will be necessary to use a cement which corresponds to about the lowest-strength cement likely to be used on the job. The use in construction of any higher-strength

[3] Design and Control of Concrete Mixtures, published by the Portland Cement Association, Chicago, Ill.

cement than this simply serves to provide an additional factor of safety, in so far as the cement is concerned. Having selected the cement, it will now be necessary to fix experimentally the relation between the water-cement ratio and the flexural strength for this laboratory cement, using stock aggregates of known satisfactory quality. The determination of the strength developed at 28 days with water-cement ratios 0.6, 0.7, 0.8, 0.9 and 1.0 will usually give enough points from which to develop this relation. Such a relation for an assumed case is shown in Figure 1. It will be observed that a ratio of 0.7 gives a strength of approximately 600 pounds per square inch.

The next step is to make up concrete specimens with each of the aggregate combinations, using 0.7 water-cement ratio and the consistency which will be used on the job. It is important in this experiment to maintain the consistency as nearly constant as possible. With a constant water-cement ratio this will necessitate variable proportions, depending upon the type and gradation of the materials. The proper amount of cement to use in each case must be obtained by trial, adding small quantities of the aggregates in question to the cement paste until the proper consistency has been reached. The predetermined ratio between fine and coarse aggregate must be maintained throughout the operation. From the final quantities used the proportions either by weight or by volume may be readily calculated. The flow table[4] is recommended for determining relative consistency in the laboratory as being more positive than the slump test. It is, however, not a test for workability in the strict sense of the word, nothing having so far been developed to take the place of the eye in judging this important characteristic.

According to the original water-cement ratio theory, concrete specimens made with various aggregates as described above should all have substantially the same strength, because the water-cement ratios are the same and the mixtures are all workable. We know from experience, however, that the strengths will probably not be the same, due to the influence of the character of aggregate. Let us assume that the following strengths were actually obtained on six combinations of material:

| Combination | Modulus of rupture in lb. per sq. in. |
|---|---|
| A | 670 |
| B | 625 |
| C | 600 |
| D | 600 |
| E | 580 |
| F | 535 |

These values are plotted in Figure 1. It is observed at once that four of the six combinations give strengths either identical or practically identical with the base or standard laboratory combination. There are, however, two outstanding exceptions, one much higher and one much lower. These two combinations, A and F, will be used as the basis for further discussion, since the same methods, somewhat simplified, can be applied to combinations B to E.

It is now assumed that had curves been developed for the relation between water-cement ratio and strength for these combinations, as was done for the base mix, the curves would be substantially parallel to the base curve over the comparatively narrow range in which we are interested. This may or may not be absolutely correct, but it is believed that for the range of mixtures covered by paving concrete it is substantially true. Granting this, we can omit the actual determination of this relationship for any of the combinations in which we are interested and simply draw through the value which we have plotted a line parallel to the basic curve. This has been done in Figure 1 for combinations A and F. To determine the water-cement ratio to use with either of these combinations to obtain a strength of 600 lb., simply follow the curve representing the material either to the right or left, as the case may be, until it intersects the 600-lb. line and use the corresponding water-cement ratio. Figure 1 shows this to be 0.85 for combination A and 0.60 for combination F. A choice between these combinations will depend entirely on which is the cheaper, all things considered, always assuming that the aggregates in both cases are structurally sound and have sufficient resistance to wear.

Before the cost can be determined it will be necessary to determine by trial method the proportions required in these two cases to give the consistency required at the water-cement ratios indicated—that is, 0.85 for combination A and 0.60 for combination F. Assume, for purposes of illustration, that the proportions for combination A with a 0.85 water-cement ratio reduce to 1:2:4 by volume and that the proportions for combination F with a 0.60 water-cement ratio reduce to 1:1½:3. Which of the two is the cheaper will, of course, depend almost entirely on the relative costs of the aggregates delivered on the job.

**Quantities of Material Determined by Simple Calculation.**—The next step is to work out for each case the theoretical cement factor as well as the quantities of aggregates required to produce a unit volume of concrete, knowing the specific gravities and weights per cubic foot of all of the materials. For this purpose a simple formula proposed by Stanton Walker[5] may be used. This formula gives the number of bags of cement required to produce 1 cu. yd. of concrete, knowing the proportions as well as the weights per cubic foot and apparent specific gravities of the materials. It is based on the assumption that, for plastic mixes, the volume of concrete produced will be equal to the sum of the absolute volumes of cement and aggregates plus the volume of water, and may be expressed as follows:

$$C = \frac{27}{0.5 + x + \frac{W_f}{62.4 S_f} + \frac{W_g}{62.4 S_g}}$$

where

$C$ = number of bags of cement per cubic yard of concrete.
0.5 = approximate absolute volume of cement in one bag.
$x$ = water-cement ratio = volume of water in a one-bag batch.
$W_f$ = weight in pounds of fine aggregate used in a one-bag batch.
$S_f$ = apparent specific gravity of fine aggregate.
$W_g$ = weight in pounds of coarse aggregate used in a one-bag batch.
$S_g$ = apparent specific gravity of coarse aggregate.
62.4 = weight per cubic foot of water.

This formula is sufficiently accurate for comparing concrete yields in the laboratory. It gives, in general, somewhat lower values for cement content than will be found by trial either in the laboratory or in the field. It will be necessary, before making final accurate estimates of quantities for field use, to make actual determinations of yield on the combination finally selected.

In the above formula it will be observed that the quantities

$$\frac{W_f}{62.4 S_f} \text{ and } \frac{W_g}{62.4 S_g}$$

represent, respectively, the absolute volumes of fine and coarse aggregate used with each bag of cement. The basis for the formula which is supported by laboratory determinations is that for given materials the absolute volumes of the aggregates used control the volume of concrete which will be obtained with a given amount of cement. This furnishes one of the principal arguments for measuring aggregates by weight instead of by volume, because as long as the specific gravity of the aggregate remains constant the weight of aggregate controls the yields irrespective of void content.

The application of the formula to the problem under discussion may now be made by continuing the illustration given above and assuming the following additional facts relative to the materials:

| | Combination A | Combination F |
|---|---|---|
| Weight per cubic foot, fine aggregate | 90 | 80 |
| Weight per cubic foot, coarse aggregate | 95 | 109 |
| Apparent specific gravity of fine aggregate | 2.65 | 2.65 |
| Apparent specific gravity of coarse aggregate | 2.55 | 2.70 |
| Price per ton delivered, fine aggregate | $1.75 | $1.00 |
| Price per ton delivered, coarse aggregate | $2.00 | $1.00 |
| Price per bag, cement | $0.60 | $0.60 |

These values, though assumed, might readily be encountered in actual practice, the idea in this case being that the aggregates represented by combination A are from sources some distance from the work, so that the cost

[4] A. S. T. M. Standards, vol. 2, 1927, p. 115.

[5] Walker, Stanton, Estimating Quantities of Materials for Concrete, Bull. 1, National Sand and Gravel Association, Washington, D. C.

of transportation must be considered, whereas aggregates F are locally available. Any other factor which might cause differences in price, such as cost of production, might, of course, just as well have been assumed.

Applying the data given in the table to the formula and remembering that a water-cement ratio of 0.85 and proportions of 1:2:4 have been selected for combination A and corresponding values of 0.60 and 1:1½:3 for combination B, the cost of materials for each combination is obtained as follows:

**Estimate for Combination A**

$$C = \frac{27}{0.5 + 0.85 + \frac{180}{62.4 \times 2.65} + \frac{380}{62.4 \times 2.65}} = 5.6$$

bags of cement.

Weight of fine aggregate per cubic yard of concrete $= \frac{5.6 \times 180}{2{,}000} = 0.505$ tons.

Weight of coarse aggregate per cubic yard of concrete $= \frac{5.6 \times 380}{2{,}000} = 1.065$ tons.

| Costs | |
|---|---|
| Cement, 5.6 bags, at $0.60 | $3.36 |
| Fine aggregate, 0.505 ton, at $1.75 | .88 |
| Coarse aggregate, 1.065 tons, at $2 | 2.13 |
| Cost of materials per cubic yard of concrete | $6.37 |

**Estimate for Combination F**

$$C = \frac{27}{0.5 + 0.60 + \frac{120}{62.4 \times 2.65} + \frac{327}{62.4 \times 2.70}} =$$

7.16 bags of cement.

Weight of fine aggregate per cubic yard of concrete $= \frac{7.16 \times 120}{2{,}000} = 0.429$ ton.

Weight of coarse aggregate per cubic yard of concrete $= \frac{7.16 \times 327}{2{,}000} = 1.18$ tons.

| Costs | |
|---|---|
| Cement, 7.16 bags, at $0.60 | $4.30 |
| Fine aggregate, 0.429 ton, at $1 | .43 |
| Coarse aggregate, 1.17 tons, at $1 | 1.18 |
| Cost of materials per cubic yard of concrete | $5.91 |

These values are not given as typical of the relative cost of concrete using imported or local aggregates, but only to illustrate a method whereby reliable information as to comparative costs may be obtained, as well as to show that the most expensive concrete is not necessarily the one containing the most cement.

There are other factors in addition to actual cost which must be considered when comparing sources of aggregate supply. For instance, the selection of materials represented by combination F in the above illustration would only be justified on the basis of an adequate supply of material equal in quality and of the same grading as the sample upon which the design is based. This, in turn, involves not only a thorough inspection of the source as to the extent and uniformity of the deposit but also presupposes adequate plant equipment for producing the aggregates. It is wasted effort to go to the trouble of designing a mix based on an examination of samples submitted for test and then find that it is either impossible or impractical to produce materials equal to the samples for the actual job. In the past most of the attempts to design concrete mixtures for paving work using local materials have failed because proper emphasis was not placed on the importance of uniformity of the material supply. Uniform concrete may be obtained in no other way.

**Effect on Specifications Discussed.**—In using the proposed method of designing concrete mixtures in actual construction, it will be necessary to change the present method of specifying arbitrary proportions to a specification based on a certain required minimum strength. Such a method of specifying has recently been suggested by J. T. Voshell, district engineer, Bureau of Public Roads, which would also involve a change in the method of bidding. Application of the proposed method of design can be worked out as follows:

Each bidder, instead of specifying a price per square yard for concrete in place, would be required to submit separate bids for all materials which he is prepared to furnish, together with a separate bid price per square yard for mixing, placing, finishing, and curing the concrete in accordance with the requirements of the specification. After receipt of proposals the engineer will examine all of the sources proposed, first, with the view to eliminating any which do not comply with the basic requirements of the specifications, and, second, in order to determine which of the materials proposed will produce concrete of the required quality at the lowest cost, using a procedure similar to that outlined above. The award should be made to the contractor who can supply the materials and mix and place the concrete at the lowest total price per square yard.

With this method of procedure the responsibility for selecting the materials and adjusting the mix to secure concrete of the desired quality, as well as the responsibility of seeing that the production of the concrete is carried out in accordance with the specifications, rests solely with the engineer. This is where is belongs, unless we are prepared to go to the other extreme and specify the quality of the finished concrete and allow the contractor to use any materials and methods of production he desires so long as he fulfills this requirement. The writer believes that we should adhere strictly to one course or the other and not attempt to control every step in the process of construction and still hold the contractor responsible for the result.

In applying the method of design described in this paper the selection of aggregates and proportions to be employed should be based on laboratory tests under controlled conditions so as to insure that when the pavement is constructed using the same aggregates and proportions and in accordance with the detailed specifications governing mixing, placing, and curing a structure of satisfactory quality will result. It is believed that under such circumstances specifications should not contain provisions as to the strength of the finished concrete, and strength tests, if made, should be for the guidance of the engineer only.

If, on the other hand, it is desired to specify the quality of finished product only, the same technical procedure for designing mixtures may still be employed, only in this case it becomes a method to be applied by the contractor instead of the engineer, because under such a specification the contractor must determine for himself the materials to be used and the proportion in which to combine them in order to make an intelligent bid.

## Proposed Motor Toll Roads in England

Lord Askwith, who is at the head of one of the syndicates undertaking the project, has given details of a scheme by which motor speed roads would be constructed in various parts of this country, with the object of speeding up motor transport, accordng to a report from Alfred Nutting, Clerk, American Consulate General, London, released by Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce.

A syndicate called Motor Roads, Limited, proposes constructing a motor speed road between London and Brighton as an experiment, provided the necessary powers can be obtained from parliament. The London-Brighton road would be built of concrete, with two tracks,—one for up and one for down traffic. If successful, similar roads would be built from London to Portsmouth, London to Southampton, and elsewhere. A small toll will be charged per mile for private cars and for heavy commercial vehicles using the highway.

Serious opposition is not expected from the railroads, said Lord Askwith who is at the head of one of the syndicates, in view of the bill which has given them road powers, but it is expected they will put in a protective clause in the syndicate's bill when it comes before parliament. He pointed out that the syndicate is a private company, and therefore the scheme will be one of private enterprise. The London-Brighton road may cost about £3,000,000, and if the other two roads (to Portsmouth and to Southampton) are carried out they may each cost double that figure. There would be no cross tracks, and the construction of the two separate tracks will eliminate the dangers of collision. There would be no speed limit, and probably the only places necessary to the motorist—such as petrol-filling stations, repair shops and garages—will be built along the road.

The road will avoid obstacles such as other roads or railroad tracks by going over bridges or through short tunnels. Motorists will be able to join the road by smaller roads, which will gradually join the main highway.

# Qualifying of Contractors on Public Works

## The Use of Standard Questionnaires Told Before Convention of City Engineers' Association

By WARD P. CHRISTIE
Engineer, Associated General Contractors of America

WITHIN the last three or four years some twenty-five state highway departments, two Federal bureaus and many municipalities have adopted the policy of qualifying bidders before permitting them to enter into a contract for construction. They have found in such procedure a means of eliminating some of the many difficulties which now attend the adminstration of public works. This idea of quilifying is not particularly new. Many public bodies have in the past declared and exercised their right to disqualify and refuse a contract to any bidder who in their opinion was incompetent to carry out a specific project and comply with all of his obligations.

The only feature of qualifying under the policy now being applied, is that it establishes an intelligent and systematic procedure which is receiving the support of not only engineers and other public officials, but also of responsible contractors. Probably the most important aspect of the new procedure is that it effectively restores to awarding officials those almost forgotten discretionary powers, which have long been theirs under the law.

As a general statement, this definition will probably suffice to indicate what is meant by qualifying, but such a generality is of little assistance to the layman or public official who is concerned with the award of a contract. Therefore, an effort is here made to break down the general definition into its components, and point out the specific things involved in the procedure of qualifying.

**Skill.**—The first of these is the contractor's skill or ability, which is a factor often overlooked in the award of both public and private contracts. Even the engineering profession has been guilty at times of assuming that any person equipped with plant and a little money or credit could execute a complicated construction project. Obviously there is no mathematical formula for computing a bidder's skill, but a reasonably accurate idea can be gained from his record of previous construction projects successfully completed.

**Reputation.**—The second factor in qualifying is the bidder's reputation for honesty in his dealings with owners, especially with reference to the quality of work performed—not that the awarding official is interested in his reputation as such, but that he may make up his mind whether the bidder, if awarded the contract, will comply therewith and deliver the quality of work for which he is paid. The fact does not seem to be generally recognized that no amount of supervision and inspection can force an honest job out of a dishonest contractor, or a well constructed job out of a contractor who is incompetent. This second factor, like the bidder's skill, is not susceptible of accurate measurement, but a sound opinion can be formed by awarding officials through the exchange of information with owners, engineers, architects, surety companies and others with whom the bidder has had dealings.

**Financial Ability.**—The third factor of qualifying and the only one of the three whereby the bidder can be accurately gauged, is financial ability. The measurement of a business man's responsibility by means of his financial statement is a process dating from time immemorial. It is used or presumed to be used in every important industry, though the construction industry and nearly everyone who deals with it has largely ignored this important item. A childish belief seems to have gained footing that any individual who can assemble a pile of equipment, buy material on credit and produce a surety bond, is competent to receive an important contract.

**Equipment.**—The plain facts of the case, as revealed by the records of construction companies, are that unless the average type of bidder owns his equipment, has a reasonable amount of cash and a contract price representing a reasonable profit, he is doomed to failure on any sizeable job as soon as he signs on the dotted line. For every type of construction and every set of conditions there is a ratio of liquid assets to volume of work under contract, which cannot be exceeded. So far no one knows what these ratios are but they are receiving study from both engineers and contractors. Eventually this study will produce some recommendations, which will be invaluable not only to awarding officials, but also to many contractors themselves.

**Ratio of Liquid Assets to Contracts.**—Tentative investigations made of several types of work indicate that under normal retained percentages, no contractor, even with his equipment paid for, is in a safe condition to handle public works if the total value of his contracts exceeds ten times the amount of his liquid assets. A number of skillful and well known contractors have stated that there had been many occasions in their business life when they would have gone bankrupt had they not had in addition to the ten per cent of liquid assets a good line of credit on the side. This ratio is considered as an extreme mimimum, which would be ruinous under specific conditions such as those established by the Barrett Law in Indiana.

Equipment and organization are of course important factors, but for purposes of this discussion, they may be considered as elements of financial resource. If the bidder has sufficient financial backing to purchase equipment and pay for a proper organization, it is probably safe to assume that he can secure them.

**Size of Contract.**—In exercising judgment, it is obviously necessary for an awarding official to consider not only whether the individual project is too big for the bidder to handle, but also whether in the sum total of his operations he has become over-extended. This common ailment of over-extension has probably caused more defaults than all other causes combined; and responsible contractors both large and small are fast appreciating the necessity of keeping within their proper limitations. In concluding discussion of this factor, it should be emphasized that the term "responsible contractor" has little reference to size, but indicates a contractor who can and will perform his contract and who maintains a proper balance between his resources and ability on one hand and the type and volume of his work on the other.

**Why Qualify?**—To understand why the procedure of qualifying on public works is gaining favor among both engineers and responsible contractors, it is necessary to visualize conditions which have developed within the construction industry. These conditions, some of which seem fundamental but actually rest upon others still more fundamental, have produced a situation which is very unsatisfactory to public construction bodies and to the industry itself. They do not seem to be generally understood, but their results are very apparent to public officials who see each year a vast number of defaulted contracts, delays in the completion of construction, direct and indirect losses therefrom, inferior quality of work, the necessity for rigid inspection and unwarrented claims for extra compensation.

Results of these same conditions reveal themselves to the responsible contractor through a situation in which he bids expecting to perform his con-

tract faithfully, against men whom he knows cannot or will not under any circumstances deliver a quality of work equal to his own. He sees the public awarding official centering his eyes on little else than the low bid, knowing that the low bid is likely to be below cost, and that the man who makes it will probably never complete the job, yet will profit therefrom by failing to pay his bills for equipment and materials.

The responsible contractor has an investment in his business and a pride in his reputation as great as that of an engineer. He feels that he cannot default but once, yet sees contracts awarded to individuals who will default today and undermine him with dishonest competition in some other locality tomorrow. With each of these defaults, the responsible contractor sees public ill will accumulate not against the irresponsible men but against himself and his industry as a whole. These are some of the things that the engineer and the responsible contractor encounter as the result of conditions prevailing in the public construction field.

**False Credit.**—While there are many such conditions to be reckoned with, that which stands out most prominently is the almost universal prevalence of what in the industry is called "false" or "automatic credit." Briefly stated the condition is such that any individual may acquire credit, default his contract and make money by failing to pay his bills.

In many instances this loose credit condition has resulted from over-production of the basic industries concerned with the manufacture of materials and equipment. High pressure sales methods are required to move quantity production and so far the manufacturing industries, with a few exceptions, likewise the dealers as a group, have paid little attention to sound credit. The lein law in many states obviating the necessity for credit investigation, has caused them to finance innumerable individuals who never had a chance to success in contracting. In private construction the situation is bad enough, but it is favorable in comparison with public work. In the latter field today it is possible for almost any person without experience, money or ability to plunge into public construction and secure a contract. If he is honest and defaults, he loses what he has and usually disappears from the picture. If he is dishonest, and defaults he can make money out of the situation and prospers, by moving from one locality to another usually about three jumps ahead of the sheriff.

Many public officials know these things, but have felt that they were obliged to award their work to irresponsible bidders because they could supply a surety bond. Yet neither the courts nor the surety companies have said or done anything to justify such a conception. The courts say that it is the duty of an awarding official to investigate bidders and award only to the lowest one who is responsible. Therefore, it is proposed that one of the principal reasons for qualifying in addition to its compatibility with sound public policy, is the fact that in practically every state it is already required by law.

These statements should not be construed in any sense as a criticism of public officials for what have been the awarding policies of the past. The uncomfortable position in which the awarding official found himself when he threw out the bid of an irresponsible man is too well known to require a comment. However, at the present time a new situation exists. The responsible contractors of the country have to a great extent become organized along sound principles of procedure. Where the public official once found himself alone and the center of attacks for following a sound awarding procedure, he now will find in most parts of the country a group of responsible contractors ready to BACK him up and sustain him in his actions. This fact, plus the increasing activities of the better element of the contracting industry to elevate contracting standards, should offer some inducement to awarding officials to qualify their bidders.

**Sound Qualifying Procedure.**—In so far as any generality may be true, it is safe to say that any qualifying procedure, which will enable a public body to ascertain the fitness of a bidder to assume a specific contract is satisfactory, but the respective conveniences of the two systems so far developed, are very different. Under one of these systems the qualifying procedure is carried on before the prospective bidder is allowed to obtain plans and specifications. Under the other system, it is carried out after bids are opened, at which time the low bidder is required to demonstrate that he can and will perform the contract.

The first system, known as pre-qualification, is not as widely used at present as the second, but it is gaining a strong foothold. To awarding officials, it offers an agreeable feature by avoiding such unpleasantness as charges of favoritism, misconduct in office and dishonesty when it becomes necessary to reject the proposal of an unqualified bidder. From the contractor's angle it is highly preferable because he learns in advance whether his proposal would be accepted, if he were low. Thus he may avoid considerable expense frequently involved in traveling, investigating and estimating the cost of a project. In the case of some projects where the contractor must know definitely about sub-soil conditions and the character of his material supply before he bids, this expense may easily run up to a thousand dollars.

When one attempts to line up the pros and cons of the two systems, the advantages seem almost entirely in favor of pre-qualification. Under it, the investigation of bidders may proceed more leisurely and in fact continuously, if the public body desires to establish a qualified list. In Wisconsin the State Highway Department qualifies all bidders and determines for each the magnitude or size of contract upon which he is considered competent to submit a bid. Though many contractors do not realize it, this method is particularly beneficial to the construction industry, in that it will often bring a realization to the bidder before it is too late, that he is over-expanding in attempting to take on a specific project. Once a man has submitted a bid and is low, he will probably exert every effort to secure the award; but when in advance he is shown by his own statement of qualification that the job is too much for him, he will often be glad to refrain from bidding.

**When to Qualify.**—The reason for qualifying after receipt of proposals in a majority of states, may be that it injects no new principle or process into the procedure. An extensive search of legal decisions has revealed nothing relative to the subject except that it must be performed before the award of a contract. Lately a decision came out of Louisiana, that School Boards and other agencies of the State could legally pre-qualify, but those public bodies following this procedure, have apparently done so because nothing forbidding it has been unearthed. Since the public body is supposed to qualify at some time before it awards a contract, it therefore seems rational to qualify in a manner that is most agreeable to the public body and to the bidder. The Bureau of Public Roads at Washington and the Treasury Department are now pre-qualifying and a recent conference of the writer with officers of the Corps of Engineers indicated that they looked with great favor upon the plan. The District Engineer for the District in which Washington is located, is using it.

In concluding remarks on proper procedure, it seems advisable to emphasize the fact that all contractors, even responsible ones, do not always know their limitations. The tendency of the industry is to expand too far and too fast. Many good contractors, who have completed a forty or fifty thousand dollar job successfully, are inclined to plunge immediately into the half million or million dollar class, with the result that they meet disaster. It is not only their disaster, but the disaster of the public as well. For this reason some of the Federal agencies have been considering the advisability of adopting some rough rule to govern expansion. No definite conclusions have been reached, but it is proposed that after a contractor has reached possibly the $50,000 class, he should not be awarded

a contract amounting to more than twice the value of any similar project that he had previously completed. In any other business, such a rule would seem ridiculous for expansion there seldom reaches such a precipitous pace, but in public construction it would doubtless prevent many defaults. Some such a policy for curbing over-expansion seems worthy of serious consideration.

**The Standard Questionnaires.**—Unless a public body desires to handle the matter of qualifying in a perfunctory sort of manner, it must obviously have some rational system for revealing the records and fitness of its bidders. The most practical system developed is that employing questionnaires and a financial statement, both submitted under oath and showing among other things the bidder's record as a contractor, his financial worth and his plans for performing a specific project.

At first glance the development of suitable forms may appear an easy task, but the experience of the Joint Conference on Construction Practices proved it to be very difficult. That body, composed of representatives from the national societies of engineers, architects, highway officials, surety companies, contractors and others worked many weeks before it arrived at something considered sufficient. This labor was performed in a spirit of public service to develop the best thought available and to save public officials throughout the country a great amount of tedious work. Also it was performed with the hope that it might prevent many mistakes and lead eventually to country wide standard procedure.

From the public official's angle, probably the two outstanding reasons for using the standard questionnaires of the Conference are: first that they have been perfected not by one individual or group, but by several who were constantly looking at the matter of practicability; and second, because of the standard feature, the process of cross checking between municipalities, states, bankers and surety companies is made very simple.

**Cross Checking Simplified.**—To facilitate this cross checking, a companion set of questionnaires to be used exclusively in financial transactions and for the most part identical with the bidder's forms, has been adopted jointly by the Clearing House Section of the American Bankers Association and the Associated General Contractors of America. As these two sets of forms are spreading rapidly in many sections of the country, and are demonstrating their worth, it does not appear advisable to encourage the development of hundreds of different forms.

From the contractor's angle, adoption of the standard questionnaire is most important in that it contains a financial statement, which is a thing that cannot readily be submitted in a dozen different forms. It would be of great advantage to construction companies, and would certainly stimulate better accounting methods, if a financial statement when taken off correctly on the standard form could be used in any state or municipality in the country. Questionnaires are about as new to contractors as they are to public officials, and some difficulty has been encountered in persuading them not to oppose the use of such forms. Naturally therefore they feel that since they are to bear the burden of making out many statements, they are entitled to the economies of standard practice. In the end no doubt such practice would prove equally beneficial to public bodies.

In closing this paper it appears not inappropriate to state that the responsible element of the contracting industry realizes that the industry is not in a satisfactory condition with respect to its dealings with public bodies. It is honestly striving to improve that condition; but it is finding just as every other business or profession has found that it cannot accomplish the job without some outside assistance from those who are in charge of public construction. The process of pre-qualifying, especially when coupled with the standard questionnaires, looks to them and to many engineers as a necessary step in the procedure. The subject is therefore presented at this meeting of public officials as a plea that they give it serious consideration, and with the hope that they will lend their hand in the country wide effort being made to elevate the standards of contracting.—The Low Bidder.

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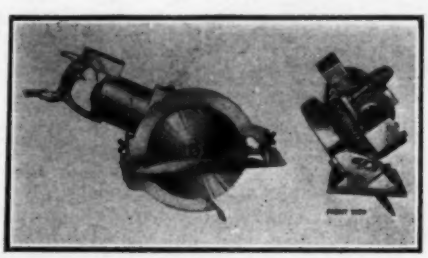
## New Type Wodack Portable Electric Saw

The new Type B "Wodack" Portable Electric Hand Saw, in addition to vertical sawing, provides for bevel sawing at any angle up to 60 degrees. This is accomplished by a tilting saw-base



**The New Type B Wodack Portable Electric Handsaw**

which can be set and locked at any angle within this range by means of a slide and locknut as shown in the illustration.

Still another new feature is that of the "Width Gauge" for vertical sawing, which can be set for any width 0 to 6 inches. With it, various widths of strips can be sawed without the necessity of marking and with greater accuracy and uniformity.

Contractors and builders in particular will find these two new features great time-savers in the cutting of roof rafters and concrete form work.

Like other "Wodack" types, the Type B has a G. E. Universal Motor of Special design which operates on both A. C. and D. C. and is furnished in 110-volt, 220-volt and 250-volt. Each saw is furnished complete with one 11 in. and one 9 in. blade ready for use.

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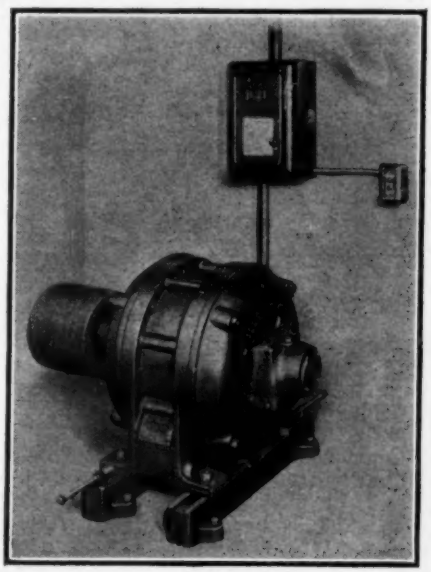
## Line Start Induction Motors

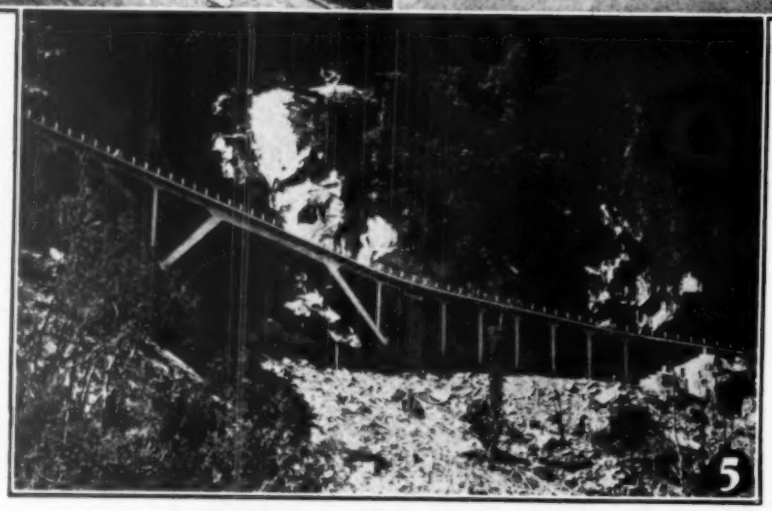
A line of squirrel cage induction motors suitable for starting on full line voltage is being placed on the market



**New Line Start Induction Motor Announced by Allis-Chalmers**

by Allis-Chalmers Manufacturing Company, Milwaukee, Wis. These motors are normal torque, high reactance machines and will not draw starting current in excess of the limits recommended by the Electrical Apparatus Committee of the National Electric Light Association. They are built in ratings 7½ to 30 HP., 600 to 3,600 RPM., low voltage, and are available with either sleeve or roller bearings. All features of Allis-Chalmers construction as employed in squirrel cage motors are maintained in this new line. A magnetic switch with push button control is the only starting equipment required.

# Two Notable Federal Highways in Brazil



(1) The New Road from Rio de Janeiro to San Paulo, Brazil.

(2) Reinforced Concrete Bridge on New Road.

(3) Road Excavation and Reinforced Concrete Viaduct on Rio de Janeiro to Petropolis Road.

(4) The New Road from Rio de Janeiro to Petropolis.

(5) Reinforced Concrete Viaduct on New Road from Rio de Janeiro to Petropolis.

TWO important highways were completed in Brazil early this year by the Commission for the Construction of Federal Highways, of which Timotheo Penteado, M. Am. Soc. C. E., is Chief Engineer. One of these connects the capital with all the south and the other connects the capital with the north and center. The sections were from Rio to the border line of the State of St. Paulo, where this State had already arrived with its roads, and from Rio to Petropolis, which will in future be extended to Bello Horizonte.

Both these roads had to overcome not only the lowland of marshes and mangroves, but also the Serra do Mar, with an altitude of over 2,500 ft. above sea-level, through a hilly zone. The difficulties were further increased by the established technical conditions which were heavy for very hilly zones.

The technical conditions established were as follows:—

| | |
|---|---|
| Maximum grade | 6 per cent |
| Minimum radius | 50 meters |
| Minimum tangents between curves of opposite direction | 40 meters |
| Width (exclusive of shoulders) | 8 meters |

These two roads were begun in March, 1927, and finished within one year.

One may judge of their importance from the following data:

**Rio—S. Paulo Road**

| | |
|---|---|
| Constructed length | 121 kilometers |
| Excavation with great percentage of rock | 2,921,464 cu. meters |
| Masonry for bridges and culverts | 15,901 cu. meters |
| Masonry for supporting walls | 6,715 cu. meters |
| Bridges | 27 cu. meters |
| Over passes | 3 cu. meters |
| Under passes | 1 cu. meter |
| Culverts | 714 cu. meters |

**Surfacing:** For the surfacing, several types were used in different sections, such as: Bituminous macadam, water bound macadam, gravel and sand-clay.

**Rio—Petropolis Road**

| | |
|---|---|
| Constructed length | 52 kilometers |
| Excavation with great percentage of rock | 1,776,872 cu. meters |
| Masonry for supporting walls | 53,200 cu. meters |
| Bridges, 10 with total length of | 230 meters |
| Viaducts, 3 with total length of | 324 meters |
| Culverts | 502 meters |

Several types of surfacing were employed, as: bituminous macadam, water bound macadam and oil treated gravel.

# Allegheny County, Pennsylvania, Operates Its Own Testing Laboratory

## Organization and Methods Described in Concrete Highways and Public Improvements

By P. J. FREEMAN

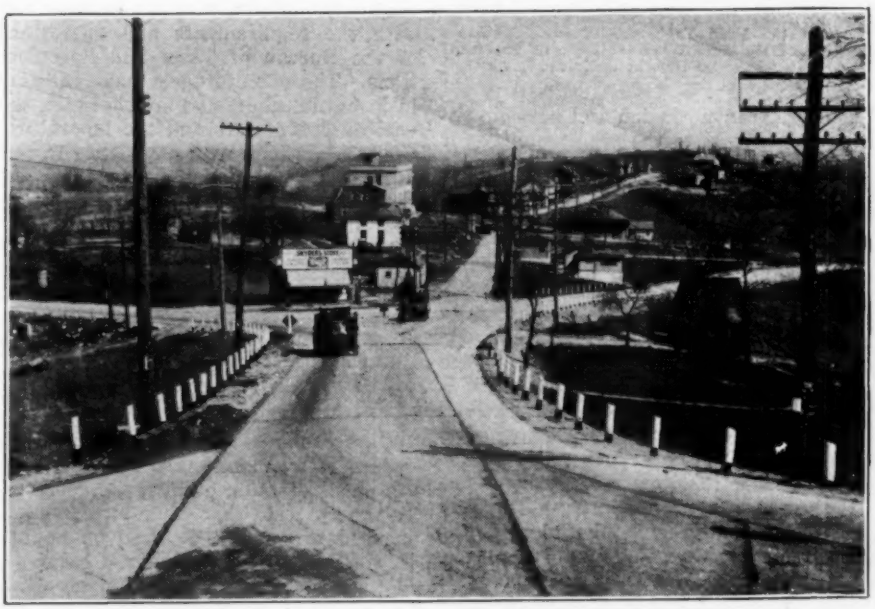
Chief Engineer, Bureau of Tests and Specifications, Department of Public Works, Allegheny County, Pennsylvania

ALLEGHENY COUNTY, PENNSYLVANIA, in which the City of Pittsburgh is located is one of the few counties in the United States which operates its own physical and chemical laboratory. The County Commissioners recognized the necessity of conserving the taxpayer's money through the application of modern methods in the selection of materials for road and bridge building. Early in 1924 they took steps to provide for the establishment of such methods.

The Bureau of Tests and Specifications is a unit of the Department of Public Works of which Norman F. Brown is the director. The work is under the direction of the writer who is assisted by a group of trained engineers, chemists and inspectors.

The full value of a bureau of this character to a community is not reflected in the number of tests completed nor in the rejections made of unsuitable materials. The testing laboratory was not established as a detective agency to discover defects in materials and construction after the work had been done, but to assist the material producers and the contractors in obtaining satisfactory materials and to properly incorporate them in the work. Rejecting unsatisfactory material is a negative procedure involving loss and trouble for all concerned. The prevention of the shipment of such materials to the job is constructive co-operation. This does not mean that county inspectors always test and approve materials before they leave the plant of the producer, but through co-operation with the producer he is given to understand exactly the quality and kind of materials required for county projects and usually his own inspection forces can prevent material from being shipped which would be rejected after arrival on the job. The policy has been accepted by the material producers and has resulted in a very small percentage of rejections when compared to the vast amount of materials used on county projects.

The field of the Bureau of Tests and Specifications extends throughout all activities of the Department of Public Works. Its organization is of such a nature that its work is harmoniously conducted in co-operation with the activities of the several other Bureaus of the Department. These bureaus, in fact, have come to regard the Bureau of Tests and Specifications as a clearing house for facts pertaining to quality or adaptability of materials they desire to use. The title adopted for this bureau indicates the broad and far flung possibilities of constructive research accomplished by the testing laboratory.

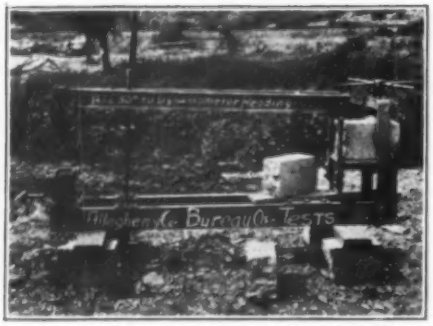


A Junction of Three Allegheny County Concrete Roads Outside of Pittsburgh

**Activities.**—Briefly stated, the activities of the bureau are as follows: (1) Preparation of specifications for materials and equipment, (2) Correlation of specifications of the Bureau of Bridges, Roads and Architecture, (3) Design and construction of field testing equipment, (4) Instruction of inspectors in the field, (5) Co-operation with producers and rendering them assistance and information concerning their manufacturing methods as applied to the needs of Allegheny County, (6) Testing materials used in construction of roads, bridges and buildings, (7) Field inspection and collection of samples, (8) Furnish information and advice to heads of other bureaus concerning materials and specifications in general, (9) Investigating paint, oils and gasoline and bituminous mixtures, (10) Conducting transverse tests of concrete beams to determine time of opening pavement to public, (12) Approval of all sub-contracts for labor and materials.

**Some Results.**—It might be of interest to state that close observation before mixing of materials entering into the manufacture of paint has resulted in a better paint at a lower cost. This item alone showed a saving of $8,000 in 1926 over prices paid in previous years. Tests made on wire rope have resulted in an exacting specification as to weight of coating which has since been adopted in several other localities. The adoption of the beam test for determining the time at which a new concrete pavement may be safely opened to traffic is another interesting development that has come about as the result of co-operation with various State Highway Laboratories. Results obtained by the beam test have in a number of instances permitted the opening of roads to the public many days in advance of the time considered safe under the old arbitrary allowance of 21 to 28 days.

Since organiaztion, this bureau has annually inspected more than 30,000 tons of steel for bridges, roads and buildings. This material is inspected by representatives at the mills and fabricating shops. Co-operating in this manner with the manufacturers has saved the county and the contractors considerable expense which might have been caused by delays in the progress of the work. Inspection at the mill is equally beneficial to the manufacturers as it saves them the needless expense



One of the Field Transverse Testing Machines Used to Determine When a Concrete Pavement May Be Opened to Traffic

of extra transportation and possible entanglements as to the responsibility for freight charges in case of rejection.

**Equipment.**—The Bureau of Tests and Specifications maintains complete field inspection equipment on every project underway. This equipment is used by the construction inspectors assigned to the project in making daily tests of materials used in the work. The results of these tests are recorded on special report forms of various kinds and are sent to headquarters every day. Here the reports are carefully examined for irregularities and unfavorable results and are then filed. If the report contains an irregularity or an unfavorable result, special attention is directed toward that particular project immediately and the difficulty is soon corrected and eliminated. "Sudden action from headquarters," best describes what takes place under these conditions.

Perhaps the most outstanding example of complete co-operation gained by the Bureau of Tests and Specifications has been that of the sand and gravel producers. Nearly all of the sand and gravel used in county projects is dreadged from the beds of large streams nearby.

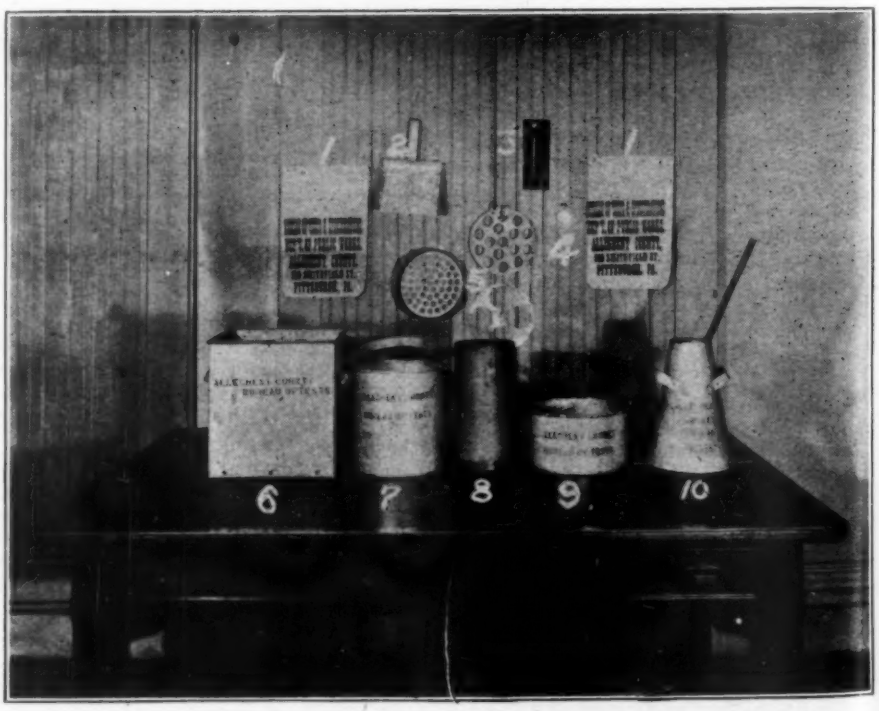
**Inspected Aggregates.**—From the beginning, we have constantly demanded clean and sound aggregates of proper graduation. Quality concrete could not be obtained without these restrictions. At first, some of the producers were reluctant in complying with the demands for washed and properly graded material. The inspectors, however, consistently rejected unsuitable material and instituted an educational campaign for the benefit of these producers. The bureau offered suggestions and other information to them concerning methods through which satisfactory material could be produced. This campaign took effect and now the aggregates used by the county are of acceptable quality and of proper gradation. Rejections are practically negligible.

**Personal Work.**—An important feature of the operations of the Bureau of Tests and Specifications is the personal work which it conducts with contractors on county work. As soon as the bureau receives notification that a contract has been awarded to a certain contractor, a letter is addressed to him, requesting him to visit the offices of the bureau to "talk it over." If the contractor chooses to be dilatory in heeding this call, a second letter is sent demanding to know the reasons for not coming and stating that a visit is expected during the next few days. Contractors usually heed the first request and visit the headquarters of the laboratory as soon as possible. At this conference the contractor becomes thoroughly acquainted with his contract and with the requirements and operations of the Bureau of Tests and Specifications. These conferences have resulted in a mutual understanding between the various contractors and the laboratory. Contractors look with confidence to this bureau for suggestions and aid in the purchase of materials and their inspection and test.

The work which the Bureau of Tests and Specifications has accomplished in the way of correlating the specifications of the various bureaus of the Department of Public Works has brought about many beneficial results. The specifications covering similar materials and usage now read alike in each of the bureaus. Curing specifications for concrete pavements have been clarified. As an illustration of this, the specifications now state that when straw or hay is used for curing, it shall be applied at the rate of three standard bales per 100 sq. yd. of finished pavement. This specification further provides that the contractor shall furnish one man and at least 200 ft. of hose for every 3,000 sq. yd. of pavement less than nine days old and that this man shall devote his entire time to watering the pavement. When temperature of 40 deg. F. or less is anticipated the contractor, upon notification from the director, must deposit concrete in the forms at a temperature of 60 deg. F. or above and find suitable means of maintaining the concrete at a temperature of 50 deg. for 72 hours after placing. At the end of that time he may cover with straw or hay as specified above.

**Money Saved.**—It is not the intention of the Department of Public Works to enter into the field of the commercial laboratory by establishing one of its own. The various commercial laboratories undoubtedly serve a very useful purpose and give excellent service to an extended field of communities. In localities where construction programs are not extensive, the use of the facilities offered by commercial laboratories is unquestionably more economical. For a large volume of work, such as has been under way in Allegheny County during the last four years, a laboratory operated by the community is more economical. Since June, 1924, the Bureau of Tests and Specifications has served projects whose total value is more than $30,000,000. The entire cost of the testing laboratory, including equipment, supplies and salaries, was about 60 per cent of the fees which would have been paid to outside commercial laboratories had they made the tests. This represents a saving to the taxpayers of approximately $40,000 annually. The laboratory equipment represents an investment of $30,000 on the part of the county.

From these figures it is quite apparent that when a large volume of work is involved, a municipal testing laboratory is most economical in conserving the taxpayer's money. Such a laboratory owned and operated by the




Field Testing Equipment for an Allegheny County Inspector

taxpayers is more capable of raising the standard of quality in materials or construction supplied to the county. The mere fact that the county has a laboratory serves as a caution to manufacturers supplying materials. Allegheny County's testing laboratory is the taxpayer's greatest assurance of quality work and of receiving a dollar's worth of material for every dollar expended.

# The Design of Highway Bridges

## British Thought Appearing in Roads and Road Construction

By J. G. REYNOLDS, M.S.E., L.R.I.B.A.

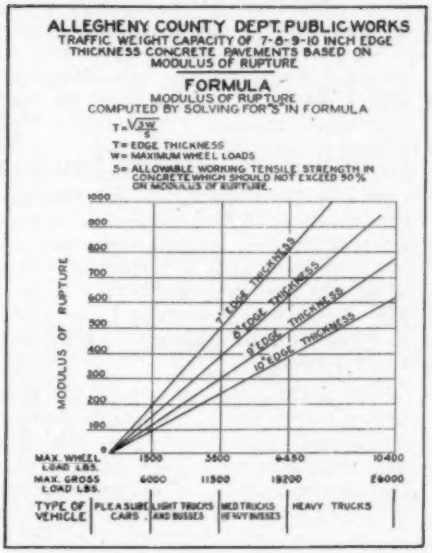
BRIDGES generally form the continuation of a road, highway, or street; in the first instance they are often built in a strictly utilitarian fashion, with attention only to details which ensure strength and simplicity; but when they form the entrance to urban districts, or are situated in prominent parts of the countryside, their construction demands attention to architectural treatment in dessign, to insure that the structure may not be an eyesore for all time.

Palladio tells us that bridges ought to have the same qualifications that are judged necessary in all other buildings, namely, that they should be convenient, beautiful, and lasting.

The perfection of a bridge consists in its having a good foundation, which makes it lasting; an easy approach, which makes it convenient; and a just proportion in its several parts; which renders it beautiful.

In the erection of bridges there are several requisites which demand attention. In the first place, the abutments not only receive the pressure of the arches with which they are connected, but they must be capable of resisting the force of the whole combined. Hence the necessity of providing such foundations at the opposite sides of the river in order to receive the earth pressure which will determine also the type of bridge.

Bridges should always be constructed at right angles to the current, and the piers not larger than absolutely necessary for the support of the arches; for when they are of an unnecessary thickness, the velocity of the current is increased, thereby rendering the foundations of the piers liable to be undermined. Lastly, we have to decide upon the number and figure of the arches, which are points of great importance to the whole, in relation to its strength, usefulness, beauty and economy.




**Traffic Weight Chart Based on Modulus of Rupture**

We find a great difference of opinion among engineers in the choice of arches, and even among mathematicians who are unquestionably the best judges of the subject; some contend that semi-circular arches ought to be preferred, because they press more perpendicularly on the piers, and in proportion to their numbers will diminish the pressure on the abutments.

Others prefer elliptical arches, when of large span and few in number, and do not press against the piers with greater force than a circular one.

Some, however, prefer the catenarian arch to all others, Emerson, in his principles of mechanics, insists that it is the strongest arch possible to be made, but Dr. Hutton, once professor of mathematics to the Royal Military Academy, asserts that the arch of equilibration is the only perfect one adapted to the principles of bridges. This arch being in exact equilibrium in all its parts, and having no tendency to break in one part more than another, is therefore the safest, and strongest. Every particular figure of the extrados, or upper side of the wall above an arch requires a peculiar curve for the under side of the arch itself, to form an arch of equilibration, so that the incumbent pressure on every part may be proportional to the strength or resistance there.

When the arch is equally thick throughout, a case that hardly ever happens, then the catenary curve is an arch of equilibration, but in no other case, therefore, it is a mistake, as some writers suppose, that this curve is the best figure for arches in all cases, when really it is the worst.

Amongst all arches there is none except the mechanical curve of the arch of equilibration that can admit of a horizontal line at the top, yet this arch is of a form both graceful and convenient, and it may be made higher or lower at pleasure with the same span or opening.

All other arches require extrados that are curved, more or less, either upwards or downwards. Of these the elliptical arch approaches the nearest to that of equilibration for equality of strength and convenience. It is also the best form for most bridges, as it can be made of any height to the same span, its haunches being at the same time sufficiently elevated above the water even when it is very flat at top.

Elliptical arches also look bolder and lighter, are more uniformly strong, and much cheaper than most others as they require less materials and labor.

Of the other curves the cycloidal arch is next in favor to the elliptical one, for those properties; and lastly, the circle.

As to the others, the parabola, hyperbola, and catenary, they are quite inadmissible in bridges which consist of several arches, but may in some cases be employed in a bridge of one single arch, which may be intended to rise very high, as in such cases they are not much loaded at the haunches.

The dimensions of the piers must be determined by those of the arch, and according to Palladio they should never exceed one-fourth, or be less than one-sixth of its width. The plans of bridge piers are generally drawn of hexagonal form, having its two long sides parallel to each other, and at the ends are placed the short ones, facing the course of the river at right angles to each other, though they are sometimes made semi-circular in order to divide the water, that drifting trees, etc., which are impetuously brought down the river when they strike against them may be thrown from the piers and pass through the middle of the arch.

Palladio assigns to the dimensions of keystones, one-seventeenth part of the width of the arch. Of a bridge which that celebrated architect designed he gives the following proportions: the river was 180 feet wide, which he divided into three arches, giving sixty feet to the centre arch, and to the other two forty-eight feet each. The piers were twelve feet thick, or one-fifth part of the width of the middle arch, and a fourth part of the smaller ones. The arches were a small portion less than a semi-circle; and their keystone, one-seventeenth part of the opening of the middle arch, and one-fourteenth part of the other two. In an arch of twenty-four feet Palladio makes the length of the keystone about sixteen inches.

The ends of bridges should open with two wings, making an angle of 45 degrees with the rest, in order to make the entrance more free; these wings should be supported by a continuation of the arches, the arch under each wing being smaller than the others. But the wings of bridges are generally supported by the solid abutments above; this only applies to cases where the bridge roadway is of less width than the connecting roads.

# The High Costs of Doing Business

## Iowa Contractor and Engineer Discuss Culvert Work in The Central Constructor

"IT strikes me that you make a deuce of a howl over doing a little on the side to make this a better job," the resident engineer on the culvert work said to the contractor.

"I've got this job on too close a margin to throw in any extras," the contractor replied. "If you wanted something else here you should have had it written into the plans and specifications. I'm perfectly willing to follow them to the letter. In fact, I figured the work that way, but I can't afford at these prices to let incidentals not called for run my costs up. They are high enough as it is."

"Don't try to kid me," the engineer came back at him. "I've been doing a bit of figuring myself. I've watched your labor and material costs pretty carefully since you started in this county. I know just what you're paying your men on these culverts and on that girder with the four approach spans. It looks to me as though there is a mighty neat profit to be made at it. I haven't the cash to tackle the bigger bridges, but I'm going to put out two culvert crews next spring and make myself some real money."

"What do you think it's going to cost you to run a crew?" asked the contractor.

"I don't have to think. I know. You're paying your foreman $8 a day; that truck driver gets $4.50; one of the other men gets $5 and the other five get $4.50 each. That makes a daily payroll of $40. This seems to be an average crew, and it will build 30 yd. of concrete a week or from 750 to 800 yd. in a season. Two crews doing that would help keep the baby in shoes, all right."

"Don't you expect to spend anything for equipment for those crews?" came from the contractor.

"Sure, but what does your stuff on this job amount to?"

**Equipment Costs.**—"Well, it amounts to more in a year than you would suppose. Come over here to the car and I'll show you what my equipment actually costs. Let's start with the mixer. I have a one-sack machine that costs $600 new. It costs me 56 per cent of that amount to own that mixer for a year. That's $336 a season."

"Here, hold on a minute. That mixer's good for four years. That depreciation ought to be 25 per cent. You fellows just throw in a lot o' imaginary costs to make the thing look bad."

"That's right," the contractor admitted. "It will last four years. The depreciation alone will be 25 per cent a year. But there is the interest on my investment of 5 per cent, shop repairs of 10 per cent, repairs in the field, 10 per cent more, storage and incidentals add 4 per cent, insurance 1 per cent and taxes another 1 per cent. That makes a total of 56 per cent. These are not just assumed figures. They are compiled from the joint experience of the members of the Associated General Contractors over a period of years and are published in a construction equipment schedule published by the A. G. C. My own experience since I have been in business tallies almost exactly with these figures.

"In addition to the mixer the crew uses a trench pump, the supply pump, a truck and small tools. Let me show you the items with their original cost, the percentage to be charged against the work each year and the annual cost of owning and operating this equipment:

| | Original cost | Annual per cent | Annual cost |
|---|---|---|---|
| 1-sack mixer | $ 600 | 56 | $ 336 |
| Trench pump | 250 | 75 | 187 |
| Supply pump | 150 | 61 | 91 |
| Truck | 600 | 76 | 456 |
| Small tools | 150 | 96 | 144 |
| Total | $1,750 | | $1,114 |

**Charges Per Unit.**—"You've been figuring labor and material costs on these jobs. Now look over the equipment costs. If I can keep this crew busy and build the 750 yd. a season you set as an average, I have to charge that annual equipment cost against 750 yd. and 400 yd. a season, as I'm doing this year, the equipment cost goes up to about $3 a yard.

"Of course, this is just one item in addition to the materials and labor you mentioned. Are you taking into account compensation insurance, surety bond, my traveling expenses in attending lettings and arranging for materials, my own salary and the cost of running the office and the cost of shipping this crew and equipment halfway across the state. Now, do you think that leaves much profit?" The engineer scratched his head.

"Well, I have noticed that these culvert men are all becoming bridge builders."

**Bridge Equipment.**—"While we've got the book open, let's tabulate the annual costs on bridge equipment. I'm figuring on two contracts a season for the crew that's working on that plate girder with the four approach spans. You've already checked the material costs. How much did you put down for labor for that crew for four months?"

"I estimated it at $6,000," the engineer said.

"Pretty close. If I get through on time it'll run $6,700, according to my own calculations. We'll just leave out materials and the dozen and one other items we mentioned as general operating expenses, and consider equipment. This is what I include."

| | Original cost | Annual per cent | Annual cost |
|---|---|---|---|
| 10-sack concrete mixer | $1,200 | 56 | $ 672 |
| 20-horse gas hoist | 1,350 | 43 | 580 |
| 4-in. pump with 2 hp. engine | 800 | 75 | 600 |
| Air compressor and riveting outfit | 500 | 81 | 405 |
| Supply pump with small engine | 150 | 61 | 91 |
| Truck | 600 | 76 | 456 |
| Derrick | 500 | 38 | 190 |
| Pile hammer and cap | 150 | 33 | 50 |
| Small tools | 300 | 96 | 288 |
| Total | $5,550 | | $2,332 |

"There are 600 yd. of concrete in this job. Now, if I can get another one like this, that will give me 1,200 yd. of concrete for the season. If I don't get the second job my whole annual equipment cost must be charged against this one project. It amounts to more than $5 a cubic yard of concrete. Of course, this is a rough figure, because some of this equipment should rightfully be charged against the steel erection. If I do get another job this cost per yard will be cut about in half."

"Well, that's still quite an item."

**Form Lumber.**—"Of course we haven't mentioned form lumber. The cost will be $1,200 on this job. And my cofferdam I figured at $400. Now look over the costs. You already know my material and labor costs. Put in the equipment, the cofferdam and form lumber and at least $1,000 for incidental costs, such as the foreman's board in the field, wire, nails, etc. Add my insurance and bond and the cost of moving in; deduct the total from $25,000 and see how much is left for profit after charging off my overhead."

"Not so good. No, not quite so good as it looks from the other side." The engineer was puzzled. Finally he asked: "How do you account for so many bridge firms bidding on this work, then?"

"That's not the answer," the contractor replied. "If you consult the records at Ames you will find that there are just eight contractors bidding on bridge work who were in the business in 1913.

"Hundreds of contractors have started in the bridge business in the last 15 years, but most of them had about the same ideas of the business that you had. They don't last long, but they're tough competition while they're taking the work."

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**New 400 Mile Highway in Gaspe District, Quebec.**—The Province of Quebec has just completed a new 400 mile highway in the Gaspe district. This road which is known as the Gaspe Belt Highway, runs east along the shore for something like 200 miles from Cape Chat, it then turns inland and is linked with the Montreal-Quebec-Rimonski Highway, thus opening up for tourists a road nearly 1,000 miles in length, extending from Montreal to the Gulf. Its scenery of land, river and sea is said to compare with any to be found in this part of the world.

# Construction Methods on Federal-Aid State Highway in Northern Illinois

## Grading and Paving Methods Used on 12 Mile 20 Ft. Concrete Job

ONE of the Federal-Aid State Highways in the State of Illinois, recently under construction, affording means of approach to the City of Chicago from points east and south, is Route 51. Sections 103 and 104 of this route, to a total length of about 12 miles, were being paved when the work was visited recently. The project consisted of grading the route and improving with a 20-ft. standard Illinois section concrete pavement. The contractor was the Powers-Thompson Construction Co., of Joliet, Ill.

**Rough Grading.**—Rough grading was a rather simple matter on this job since the country traversed was gently rolling and cuts and fills did not exceed four or five feet, except in the first mile. Balance points were close together. This part of the work was sublet to F. C. Wekerline, a grading contractor, who used a ¾ cu. yd. steam shovel loading into motor trucks on the first mile, where the heaviest cuts and fills were encountered, and used 2 elevating grader outfits on the balance of the work. The elevating graders were pulled by caterpillar 60 tractors, and each was served by dump wagons drawn by 3-up teams. The soil was mostly stiff clay, with some gravel and small boulders. Using a varying number of teams depending upon the haul, each grader outfit was said to have been able to move from 500 to 600 cu. yd. of dirt per 10-hour day.

**Fine Grading.**—Fine grading was done with Bates 40 caterpillar tractor, pulling a grader and a stone boat used for moving forms, a Lakewood subgrader, a Twin-City tractor converted into a light roller, and two 2-up slip teams. A crew of 8 men was used on the fine grading work. Performance was at the rate of 900 to 1,000 lin. ft. of subgrade prepared for paving each 10-hour day.

**Setting Forms.**—Forms were set by a crew of 2 form setters, at the rate of 2,000 lin. ft. of forms, enough for 1,000 lin. ft. of roadway, per 10-hour day, or less of the subgrade had not advanced that far. Trench for the forms was cut with a Carr form grader, manned by one operator. This machine had no difficulty operating in the clay, in spite of the fact that dry weather and hauling had brought the surface to a very hard condition. This machine could cut to a depth of as much as 14 in. in this hard clay at a rate sufficient to give the above progress. Forms stripped from the completed pavement were taken up to the form setters each day on a stone boat pulled by the Bates 40 caterpillar.

**Batching Plant.**—The proportioning plant was located near the midpoint of the job at a point made accessible by a cross road and on a switch track alongside a railroad crossing the work. Cement and aggregates were delivered by rail to this switch track. The cement was unloaded directly from the car into the trucks by way of a platform constructed for the purpose, just inside the entrance to the plant area. Further along, the aggregate cars were spotted on the switch track, and unloaded by a Northwest crane equipped with a 1¼-yd. clamshell bucket. By means of this crane the aggregates could be unloaded into stock piles or into a 50 cu. yd. C. S. Johnson sand bin and a Harris bin of the same size for gravel. The batches were measured into the trucks from these bins by Johnson batchers suspended beneath them in the usual manner. The stock

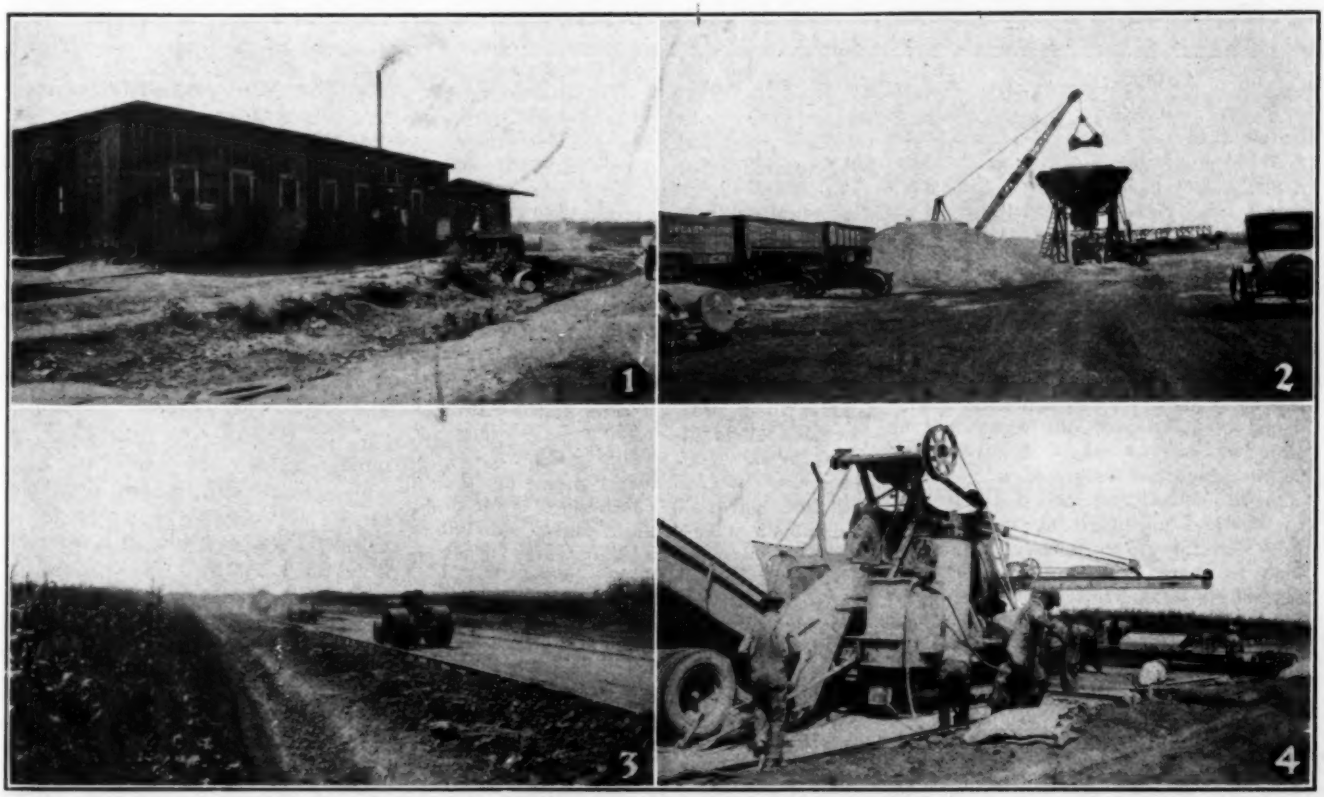



Fig. 1—View of Mess Hall at the Camp, With Facilities Outside So That the Men Can Wash Up Before Meals. Fig. 2—Aggregate Proportioning Equipment at the Same Point. Fig. 3—Fine Grading Gang at Work. Fig. 4—Mixing and Finishing Operations in Progress

piles are used to permit unloading the cars as they come in regardless of whether or not the paver is operating. This saves demurrage in bad weather and affords an extra supply should delivery facilities be interrupted from any cause. The crane, as usual, can handle aggregates equally as well from cars to bins as from cars to stock piles and from stock piles to bins.

With a distance of about one mile from this batcher plant to the paver, 10 trucks were used.

The camp is located at this batching plant.

The batching plant layout required the services of 4 cement hands, one crane operator, one oiler, who also served as a car cleaner, and one batcher.

**Paving Operation.**—The batches were delivered to the paver in 2-batch motor trucks operating on the subgrade only as much as was absolutely necessary, utilizing the side roads as far as possible to minimize tearing up the subgrade. The paver used on this work was a 27-E Rex paver equipped with a "mechanical man," a new device recently put on this make of paver. With this paver, and with truck delivery carefully coordinated, it was possible to average a batch every 1 minute and 22 seconds. Timing of the mixing cycle over several cycles verified this figure and showed that with the paver set for a mix of 60 seconds, the actual mixing time was 62 seconds. This was due to the apparent cause of there being a dead time of 2 seconds from the bell to the time discharge started, it taking this long for the "mechanical man" device to start operating. This device seemed to make the job of the operator much simpler, and in the long run to speed up the operation of the machine.

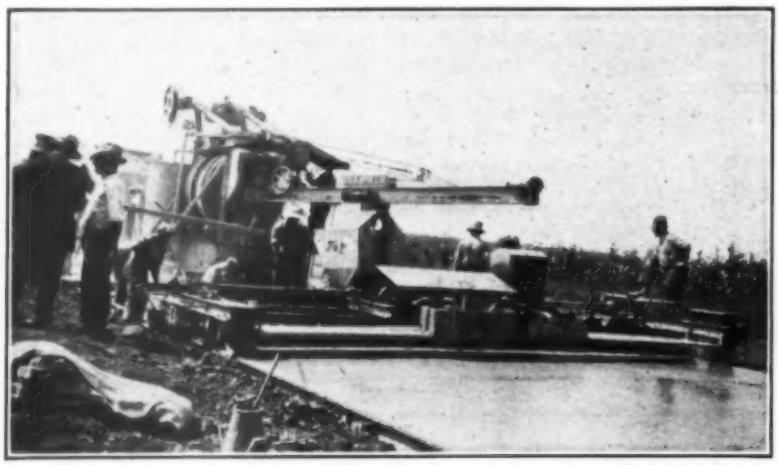


Fig. 5—Another View of Paver and Finishing Machine at Work

**Finishing.**—The concrete deposited on the subgrade was puddled in the usual manner after steel had been set, and finishing was done with an Ord finishing machine and then hand edging and one belting, after which the slab was covered with wet burlap until the following morning, when this covering was removed and calcium chloride spread on the surface for the sake of further curing.

**Forces on Paving.**—The forces used on this department of the work included the following men:

1 Paver operator.
1 Finisher operator.
1 Dumper.
2 Following template.
4 Puddlers.
1 Laborer, center steel.
1 Labor, side rods and oiling forms.
1 Finisher.
1 Edger.
2 Laborers on curing.

With this organization and equipment, while paving a standard 20-ft. Illinois section, the contractor could lay and finish on the average of 840 lin. ft. of pavement per 10-hour day, counting all delays. Water was pumped from 1 to 4½ miles through a 2-in. pipe by means of a steam boiler and high pressure steam pump.

**Shoulder Work.**—It was planned that the shoulders would then be roughed-in by means of a Ryan blade grader pulled by Cletrac tractor, and that finished sloping would be done in the usual manner.

**The Camp.**—Since the work was not very accessible to the city, it was necessary to establish a camp in order that meals and lodging could be supplied close to the work. This camp was established at the same point as the batching yard, and consisted of a kitchen and mess hall, bunk houses for 100 men, a blacksmith shop, and other facilities. The buildings were of the type shown in Fig. 1. A cook and three helpers and a yard man took care of this unit. The camp was run by the contractor, and the best of food was supplied for the men. Lunches were packed up each day during operating weather and hauled in a motor truck to the location of the various gangs, thus eliminating the time lost by transporting the men to and from the camp at the lunch hour.

**Those Responsible.**—The contractor, Powers-Thompson Construction Co., was represented on the work by E. E. Du Pree, superintendent, and the State of Illinois was represented on the work by C. E. Groscoff, resident engineer, working under the direction of G. N. Lamb, district engineer. The Federal government was represented by J. T. Voshell, district engineer, U. S. Bureau of Public Roads.

## Tandem Maintenance in New Mexico

Excellent results are stated to have been received in New Mexico in the maintenance of gravel and earth roads by the so-called tandem method. This method, in brief is as follows:

Two units of equipment are used in tandem, one following closely behind the other, the two spaced at such an interval that approaching traffic may turn out for the front machine on the right, passing the second unit on the left. The purpose of this tandem arrangement is to completely cover the road from shoulder to shoulder in one operation, thus giving maintenance to the full width of the roadbed and at the same time cleaning it of any rock, ridges of earth, sand or debris of any nature that might furnish a hazard to traffic. The scheme necessarily provides for the casting of the loose material from one shoulder directly across to the opposite shoulder instead of casting from both shoulders toward the center, as is ordinarily done in maintenance operations.

According to Colorado Highways the direct advantage of this plan is twofold: First, it results in a flat crown roadbed which is generally admitted to be the proper design for fast-moving automobile traffic. Second, it eliminates absolutely the ridges of loose earth, rock, sand and debris that are of necessity left in the center of the roadway when only one machine is in operation upon a patrol until the operator is able to make his return trip. Breakdowns, bad weather or other adverse conditions may delay this return trip several days.

The "tandem" method of maintenance affords a complete covering of the roadbed on a single trip through a finished road as the operators proceed. A double covering is made on a complete round.

The equipment adapted for this type of maintenance may consist of a 5-ton tractor with an 8-foot grader provided with right and left extensions, this unit to be followed with a motor grader equipped with a 12-foot blade of some standard type of maintenance or drag equipment. The main idea is to arrange the two units in such a manner that they will have sufficient blade capacity to fully cover the roadbed.

# The Modern Tendency in the Highway Design

## New Factors Which Must Be Taken Into Consideration

By HAROLD GIFFEN
Field Engineer, New Jersey State Highway Department

THE subject of highway designing should be approached from the viewpoint of its use by present-day types of motor vehicles. The principal use is still that of the pleasure vehicle, including the business use of this type. The increasing use of the freight-carrying vehicles is to be noted, but perhaps the use which will most modify the design of the highways of the future is that of the passenger bus.

**Higher Operating Speeds.**—The outstanding tendency in the use of all classes of motor vehicles today is that of greatly increased operating speeds. The public will gain in economy and convenience and highway transportation will be benefited by the higher speeds if there is not a corresponding decrease in safety of operation. Safety devices on the vehicle have kept pace with the new speeds. Judging by the offerings of the manufacturers, even higher average speeds are to become common. This places the burden on the designer of adapting the highways to higher speeds. In so far as possible, those safeguards which can be built into the road must be provided.

More vehicles and the increased radius of operation with more miles per vehicle only emphasize the need of additional road space, the elimination of road hazards, and decreasing of obstacles to higher average speeds.

**Increased Use of Interstate Passenger Buses.**—While there is no doubt about a steady increase of highway transportation and the importance of highways in the general transportation scheme, it may be rather interesting to note a concrete instance. Since the opening of the Delaware River Bridge between Camden and Philadelphia, there has been a great increase in the use of the interstate passenger bus. This has decreased the passenger revenues of the main railroad feeding the territory adjacent to the bridge on the Jersey side more than $1,000,000 in a single year. The two railroad companies affected have reduced their passenger fares in the district an average of 45 per cent to meet this competition. One company advertises that these reduced fares are offered as an experiment to determine whether the public prefers to ride on rails or rubber, and what the future train service will be.

Although no engineer would advocate at this time, or probably at any time in the near future, the substitution of highway transport for rail transport entirely for passenger service, it cannot be denied that the passenger bus can and does perform a service which the steam railway cannot. Much improvement in the reliability and safety of bus service has justified its extension. Whatever the outcome of this particular "war" between transportation utilities, the highway designer must note the increasing tendency of the motor vehicle to usurp the functions of the railways.

Just to what extent the presence of many large and speedy buses on the highways will affect the design is somewhat uncertain at this time, but it is going to be one of our big problems. If these units could be kept moving on the highways it would simplify the problem some, but their stopping on a crowded highway for the loading and unloading of passengers affects the capacity of the roadway and the safety of other users of the highways.

**Influences Affecting Amount of Traffic.**—Before examining any of the features of highway design, attention should be directed to other influences which will affect the amount of traffic in the near future. On the borders of this state there have been recently completed two new entrances to the state from the densely populated sections of the adjoining states. Four others are under construction and as many more being planned and promoted. In the last two years the facilities of entrance to the state have been greatly increased, and this has been followed by a great increase in traffic. Those now under construction and proposed will undoubtedly add much more traffic to our highways. If the increase in traffic is going to continue as it has lately, many of our present highways may be inadequate within a comparatively short time. Since there is within ten miles of the borders of our state, more than twice the population within the state, it seems that with the increased facilities will come a great increase in traffic. This has heretofore been held back by the intervening streams and inadequate ferries. While there may not be this particular condition in the other states of this association, it is likely that similar conditions exist which will have very much the same effect on future traffic.

**Alignment Most Important Feature.**—The most important feature of highway design is the alignment. Each section of highway is a separate problem and just how it is solved depends on the amount of money it is justifiable to spend. There are times when a shortening of distance can be shown to have a definite money value, but how much is the decrease of curvature worth in dollars? Although we have not yet found a way to evaluate such things it has seemed in the past that improvements in alignment have certainly been worth more than their cost. The importance of good alignment is no less today than in the past, and we will probably in the future feel justified in the expenditure of more money than we are spending today. How many times in the past has the good alignment built into a road been criticized as too costly? All of us can point to numerous examples of too cheap alignment.

One of the features of highway alignment which merits more attention than it has received in the past is that of sight distance. For a vehicle to go into the line of approaching traffic to pass another vehicle a sight distance of about 800 ft. is desirable. Probably somewhat less than this will answer in many cases without any bad results. Less than half of this will not allow passing without hazard. An extra traffic lane should be added where the sight distance is less than 500 ft. If this cannot be done some warning, such as a traffic line, should be built into the pavement or painted on it. The use of the traffic line should not, however, be indiscriminate nor should it be longer than necessary. It is better to spend money in making the roadway safe and adequate than to be too generous with warnings.

To obtain sufficient sight distance it is sometimes necessary to increase the graded width or to cut a shelf in the slope. On the summits of vertical curves the lengthening of the curve will often give the required distance. It must be remembered that short sight distance due to a summit in the grade is more dangerous than in the case of horizontal curvature because it is less apparent and the hazard is too often unlooked for by the driver. A vertical sight distance of 600 ft. is little enough for a two lane road. This, of course, pertains to the highway in the country and less to streets in municipalities where lower speeds must necessarily be used.

**Banking Pavement on Curves.**—The question of banking the pavement on

curves has been discussed for several years. Experience has disclosed some disadvantages. A curve which is banked invites speed. Unless the other conditions are particularly favorable to speed, a hazard is created. Parked vehicles, road intersections, short sight distances with narrow pavements sometimes cause trouble which can, in part, be attributed to the banked pavement. Snow on the upper side of the road melts and keeps this portion of the pavement wet for days at a time. When this freezes a sheet of ice is formed over a pavement which may be perfectly dry at other points. A banked curve is not a good place for an icy pavement when drivers are expecting a dry pavement. Present day motor vehicles have quite low centers of gravity and can easily negotiate unbanked curves at any speed allowed by other conditions, and it would seem that the banking is unnecessary and unwise.

Grades of highways are generally fixed close to the surface of the ground. Once a highway is laid out, only minor variations are justifiable. The general grade is more of a location problem than one of design. Heavy cuts and fills are sometimes unavoidable, but indiscriminate cutting off the tops of hills and filling in the low spots for slight decrease in grade is not to be encouraged. While no fixed rule can be given to cover all cases, it is well to keep the grade as close to the natural surface of the ground as possible and still give a smooth grade which isn't "choppy." Rise and fall should be considered in comparing possible locations, but once the location is selected, the rise and fall does not affect the laying of the grade line. Grades at intersections must be carefully worked out to avoid danger to cross and turning traffic.

**Effect of Abutting Property on Grades.**—Grades are very much affected by the abutting properties. Whatever the legal aspect of the case, the abutting property owner has a moral right to a grade suitable to the conditions of his property. Reasonable access to the property from the highway cannot be denied. Not that the property owner is entitled to entrance at all points without any expense to himself, but the access must be sufficient considering the use of the property. In the interest of the general public it is often necessary to fix grades which are something of a hardship on the abutting property owner. Unless there is also a compensating benefit for which the owner does not pay, the public should pay for the added convenience or safety.

Years ago when the problem of the highway officials was to get the motorist out of the mud it was thought that when a good hard surface was provided he would not get off it. The improvement of shoulders was considered an expensive luxury and not at all necessary. Now that we have emerged from the mud and travel at a high rate of speed we must give some attention to what happens when the motorist gets off the edge of the pavement. This will happen due to carelessness, the necessity of dodging at an intersecting road or crowding at other points, parking, or in case of the bus, to take on and discharge passengers. While the shoulder should not invite traffic, it should be constructed to serve as an emergency pavement. It should be sufficiently improved by the addition of some good material that will make it firm and usable at all times. It should be wide enough for a parked vehicle to entirely clear the main pavement with room to walk around the vehicle.

**Sidewalks for Pedestrians.**—A question that has been bothering highway officials for some little time is that of providing for the pedestrian. Is the governing body that builds the roadway in any way responsible for the convenience and safety of pedestrians? Although the building of sidewalks has always been a municipal function, the cost of which is borne by the abutting property owner, it has become as much a matter of public safety as private convenience. The State Highway Commission of New Jersey is not authorized to build sidewalks, but sidewalk space is always provided and the grading often done, hoping that the local officials will see that sidewalks are constructed. Too rarely they do. The designer should, however, assume that in the near future some way will be found to build sidewalks along many parts of the main roads, and plan accordingly.

Recently much time and money has been spent in research to determine suitable and economical structural designs of pavement and undoubtedly much progress has been made. We have learned much about the inherent weakness of the edges and corners of the slab. More improvement in strengthening the weak places must be had before we are going to be free from corner breaks and transverse cracks. And we are still uncertain on the spacing of joints, their method of placement, the thickness of pavement, and the amount and spacing of reinforcements. The proper placement of dowel bars is still a problem—not only of inspection, but of design. The concrete dowel, or tongue and groove, might prove successful if used on a deep joint, but has insufficient strength on an 8 in. joint. The binding of the slabs due to poor alignment of metal dowels is probably the cause of some transverse cracks and spalling at the joints. The economy of reinforcement is still debatable.

**Pavement Crowns.**—The necessary crown of a pavement depends upon the kind of pavement and the care in constructing it. The circular or parabolic crown is suitable for the macadam or gravel road, but is unsuitable for any pavement which is hard and smooth and constructed one-half at a time. The modern concrete road with a flat surface does not need more than 1 in. drop in a 10 ft. slab. This is sufficient to drain off the water and is less annoying to traffic. The tendency of a high crowned road to keep the vehicles near the center decreases the capacity of the highway and is less safe for passing traffic. While a slight pitch in the crown is better at the center of the roadway, there is a different condition at the curb line. Since vehicles do not travel closer to a curb than 3 ft. there is no need for designing this 3 ft. strip as part of the travelled way. It should be used to carry water and for parking, and because of the pitch necessary for confining the flow of water, should be constructed separately. It should not be included as part of the lanes of travel, but in addition to the required width for traffic.

**Traffic Lanes.**—The paved width should allow 10 ft. for each lane of moving traffic and 8 ft. for a parking lane. Diagonal parking requires double this, but except in special cases, the convenience of diagonal parking does not compensate the inconvenience of moving traffic, and its use on through traffic routes should be discouraged as uneconomical.

Increasing the width above that required for two lanes of moving vehicles has some influence on other features of the design. The use of the center lane of a 3-lane road for passing traffic in both directions creates a traffic hazard, in that the 3-lane road is really used by four lines of traffic. The center lane is used by the vehicle that gets possession and holds it. There is a constant tendency for drivers to edge into this lane and "bluff" the approaching driver out of it. This makes a more or less continued fight for possession, in which the cautious driver loses. This center lane is a sort of "No Man's Land," to be taken and given up intermittently. The hazard is, however, very apparent and makes for alertness on the part of those using it. It works fairly well when the sight distance is sufficient to see approaching vehicles. Short vertical curves on summits, sharp horizontal curves and intersections considerably lessen the use of the center lane. At such points the tendency is to use only two lanes, or the introduction of an extra hazard which only the reckless drivers will take. The gradual widening to four lanes, together with a traffic center line distinctly marked at such points, will make the highway function better, reduce the hazard and increase the average speed. Where traffic lines are needed they should be painted on the pavement. Construction joints cannot serve as traffic lines. Traffic uses such road space as there is without any regard to the location of joints.

**Road Intersections.**—With the increase in amount of traffic, the highway designer will need to give much more study to intersections. The ordinary type of intersection limits the combined capacity of two roads to that of the greater. Additional width of pavement at the intersection and for a short distance either side will help this condition. Longer radii at turns helps to clear the intersection quickly of the turning traffic and increases the capacity. We are rapidly approaching the point where many special intersections, such as circles, divided intersections, and grade separations with and without ramps will be used. This is both a traffic and structural problem with much uncertainty and insufficiency of data to prove the economics of the design. Although economic solutions to these problems are regarded with suspicion by many practical engineers, it is quite probable that more faith will be had in them when we know more about the distribution and regulation of traffic, and acquire reliable data for our assumptions. Too many assumptions which have great influence on the results are too far from the truth, and too many factors are entirely ignored or misinterpreted. It is unfortunate that calculated economies are regarded as ridiculous. More information better interpreted will change this.

Certain tendencies in regulating traffic must be noted by the designer. First is that of allowing a right turn on a red light. Second is that of having left turns made on a green light from the center of the road without passing around the center of the intersection. While this paper cannot go into a discussion of these tendencies, these and others should be noted and studied by the designer.

Most of the improvements in design of highways of the future are going to cost more money. The danger of spending too little money is greater than that of spending too much. Too much of our work of recent years is inadequate for the needs of today. There is little economy in skimping the design to keep down costs, but there is criticism by the public. The designer should always be asking himself "Is this going to be adequate for most of the life of the improvement?"

**The Esthetic Side.**—There is a growing tendency to give more consideration and attention to the esthetic side of road building. Many are wondering if the ugliness of some road construction is necessary. The marring of a beautiful section of country with poorly trimmed slopes does not meet with public approval. Highway officials have hesitated to spend the taxpayers' money for so-called uneconomic purposes. Each year the public votes for the expenditure of greater sums for parks and parkways, and spends more money in the appearance of private property. Beauty is demanded in public buildings and many engineering structures for which the public pays. We should not hesitate to spend the public money as the public spends its own money. While the engineer takes pride in proven economies, the public accepts these as a matter of course, but takes pride in a beautiful highway. Since we are building the roads for the public and not for the Engineer and Economist, we should give the matter a little thought. Take a lesson from those who provide the vehicles using the highways. All of them are spending money to give the public beautiful vehicles. They must know what the public wants, and we should know.

**Acknowledgment.**—The above paper was presented at the 4th Annual Convention of the Highway Officials of the North Atlantic States.

## U. S. to Play Host to European Road Builders in 1930

Leading highway officials from all parts of the world are coming to the United States in 1930 to study American methods of road improvement and road use, according to word brought back from the recent sessions of the International Road Commission at Paris, by Thomas H. MacDonald, chief of the United States Bureau of Public Roads and chairman of the Highway Education Board.

Mr. MacDonald went to France as head of the official delegation representing the American government at the road meeting. He later made an investigation into phases of highway development in many of the countries of Western Europe and in the British Isles.

"Not only was the invitation extended by our Congress through President Coolidge accepted unanimously," said Mr. MacDonald, "but from comments of delegates from other countries, it is evident there is a deep-rooted, world-wide interest in what is being done to improve highways here.

"The great distinction which exists between our program and that of other nations, is that while here the whole country has adopted motor transportation, elsewhere car use is still largely in the hands of a few.

"The rapid expansion in the United States faced our engineers with an urgent demand for the immediate improvement of hundreds of thousands of miles of highway. At the same time, increased valuations growing out of bettered transportation facilities and a moderate tax upon the vehicle itself made it actually cheaper for the public to have roads than to go without them, so that we were able to embark upon a construction program without parellel in the history of public works without dislocating our financial system.

"Concurrently, we were faced with the question of whether it was cheaper to build these roads slowly and laboriously by human labor as most other countries now do, or whether we should work out mass production methods and so meet the national demand quickly. Experience has demonstrated that the latter plan is by far the more efficient and less costly.

"Foreign highway engineers who are as well or better versed in the technique of road building as our own men, in the main are only now arriving at the stage where they must meet similar problems in their own countries, hence their interest in the sessions here in 1930.

"Further, because of the wide diversity of geographical, climatic and soil conditions in the United States, coupled with varying degrees of wealth and population, it is possible to approximate here the basic problems which confront engineers from abroad, whether they are interested in congested areas, such as England has, in primary roads, such as are needed in the newer countries, or in questions of mountain roads, such as face Austria, Switzerland and other nations.

"So that the United States in 1930 will be a giant laboratory in highway development and motor transportation where highway officials from other countries will find an opportunity to see not only what has been accomplished from an engineering point of view, but also to observe both the social and economic influences which have been effected.

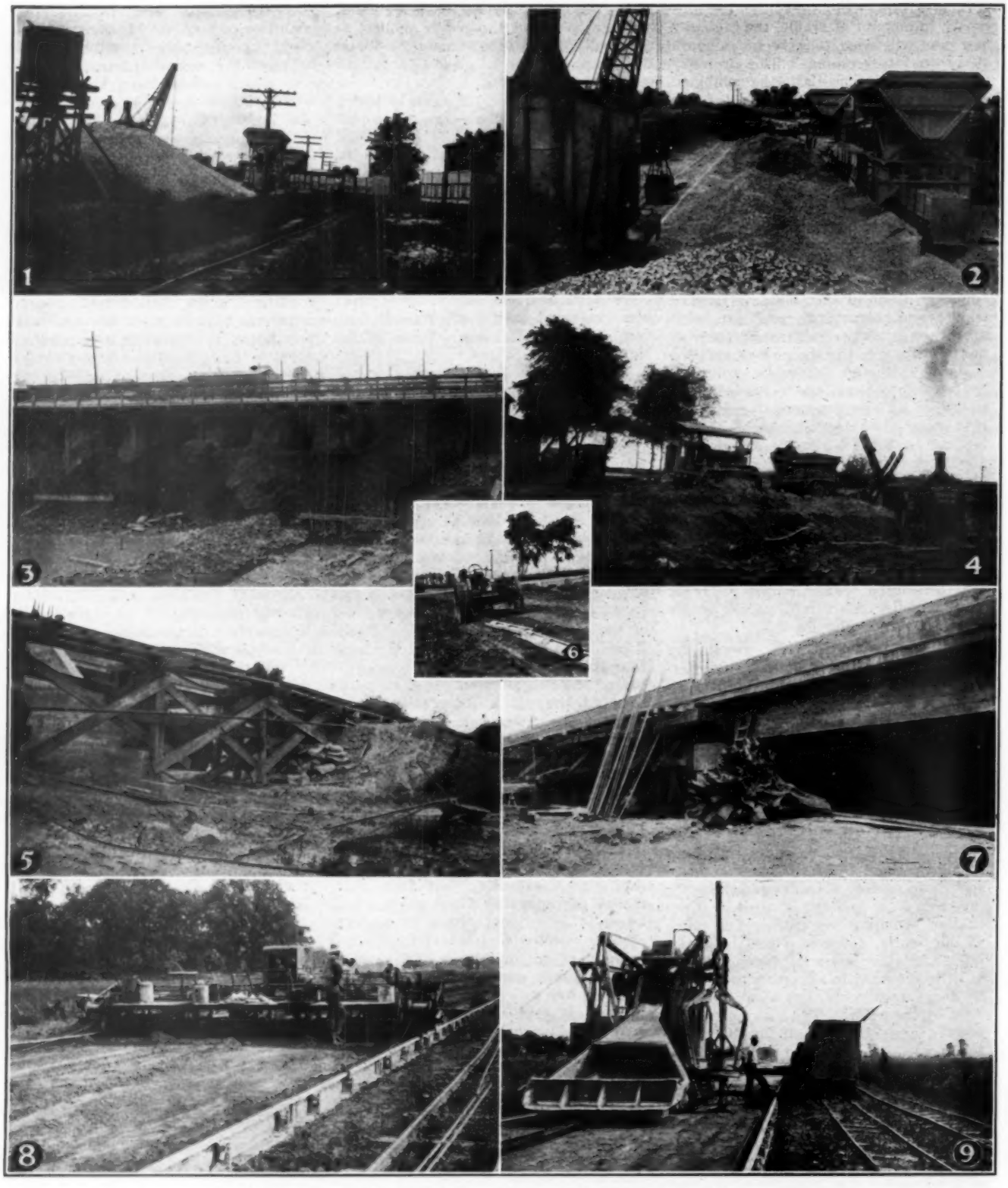
"At the same time, our engineers will have opportunity to learn what is being done in other countries and to compare notes with their foreign colleagues."

Aside from Mr. MacDonald, members of the United States delegation to the International Commission were H. H. Rice, treasurer of the National Automobile Chamber of Commerce, Pyke Johnson, executive director of the Highway Education Board, and H. H. Kelly, Commercial Attache, representing the Department of Commerce.

An American committee will be named soon to take charge of the work of preparation for the Congress.

## Mexico Pledges Support in Construction of Pan American Highway

Pledging the support of the Mexican Government towards the construction of a Pan American Highway, Luis Montes de Oca, Secretary of Finance, told the delegates to the Second Mexican National Highway Congress and Exposition, that it would not be more than three years before such a highway could be completed. "Conditions in Mexico are better than they have been for many years," he declared. "The construction of such a highway would mean the cementing of a closer bond between Mexico and the United States and would result in hundreds of thousands of American tourists annually to the Mexican capital."




**Views of Paving and Structures on Lawrence Ave. Job.**

1.—General View of Batching Yard. 2.—Closeup View of Crane, Stockpiles, and Batchers. 3.—Opening Drifts Under Tracks for Grade Separation. 4.—Tractor and Trailer Outfit Moving Dirt from Shovel Cut on Grade Separation. 5.—View of Temporary Bridge Built for Batch Box —View of Bridge With Some Falsework in Place. 8.—Subgrader Prepar-Railway Over Des Plaines River. 6.—Carr Formgrader on Subgrade. 7. ing Final Finished Subgrade. 9.—Paver, Batch Boxes, and Finishers at Work

# Twelve Mile Paving Project Involving Viaduct and Bridge

## Notes on Methods Used by the Various Contractors on Lawrence Avenue

AS PART of the present main highway plan now under construction to afford motorists of Chicago easy and rapid access to outlying State highways leading to various points of importance, one of the interesting jobs now under way is the extension of Lawrence Avenue westward from the city limits to the county line. The new highway will be of reinforced concrete, 20 ft. in width except for intersections, where the width will be 40 ft., and involves the construction of two major structures. These structures are a skew girder type bridge over the Des Plaines River, and a viaduct under the Soo Line tracks. Interesting methods were revealed by a recent visit to the paving, the bridge job, and the viaduct excavation work.

**Industrial Haulage.**—The paving operation is based upon an industrial haulage system, with batch boxes and batch box cars hauled by gasoline locomotives. This has worked out well even though the same organization and plant was used to pave an intersecting highway, Cumberland Ave., as part of the same general project. Relaying of the track from the intersection of the two streets so as to serve the paver on Cumberland Ave. afforded but little trouble, and made it possible to pave a still greater yardage from the same batcher plant setup than would have been possible should this other street have been paved at a different time. About 12 miles of highway had to be paved with this plant, and work progressed in a very satisfactory manner.

**Proportioning Plant.**—The proportioning plant was located along the Soo Line tracks about two blocks from the road being paved, with the space between the actual plant and this intersection made available for various job purposes, such as for offices, blacksmith shop, tool shed, gasoline pumps, equipment storage, material storage, and other necessary things.

**Aggregate Handling.**—Cars of aggregates were delivered to a team track at the plant, and were unloaded to stock piles by a 15T Browning locomotive crane equipped with a 1¼ cu. yd. clamshell bucket. A 2,000 gal. elevated tank erected at this point was used to supply water for this crane, the tank being filled from the pipe line laid for the paving operations. On the opposite side of the stockpiles, and midway between them, two 40 cu. yd. Johnson steel bins were erected for batching purposes. One bin supplied sand and the other stone. These bins could be loaded either from the cars or the stockpiles by the locomotive crane.

**Cement Handling.**—Cement was delivered to the team track in box cars, and a loading platform was erected alongside the tracks so that the cement could be carried from the car and loaded onto the batches. The industrial trackage was laid in this yard so that the batch boxes could be loaded with cement and aggregates in an expeditious manner and taken out onto the main line leading to the paver with minimum switching. A four ton locomotive was used in this yard to spot the cars through the batching process.

**Yard Crew.**—The men required at this plant included the following:

1 Crane operator
1 Fireman
1 Locomotive operator
1 Loader
4 Cement hands on platform
1 Sack laborer
2 Cement hands in car

**Hauling Equipment.**—Besides the 4-ton locomotive used for switching purposes in the yard, the contractor used an 8-ton gear drive Plymouth locomotive for hauling trains to and from the mixer and a 7-ton locomotive spotting cars at the paver. Batch boxes are mounted two to the car, and 26 cars or 52 batches to the train. Angle irons riveted along the sides on the bottom of the batch boxes engage the car frames and prevent dumping loads on rough track and curves. A timber pile bent trestle was erected over the river to afford access to the paving east of that point. Batches were dispatched to the mixer at the rate of 8 trains a day. The train crew consisted only of a locomotive operator. The maximum haul was 5 miles, and at the time the work was visited the haul was approximately 3 miles. Water was secured from the Des Plaines River, pumping from a small intake channel dug for the purpose, and pumping with a 3-cyl. 4 cycle C. H. & E. gasoline driven pump through a 2 in. pipe line. The hose connection to the mixer was 1½ in. in diameter.

**The Subgrading Equipment.**—Subgrading was done with a French subgrader, slips, and light roller. The road forms were set after grade was prepared by a Carr form grader.

**Paving Equipment.**—The batches were mixed in a 27-E Koehring paver equipped with a crane for handling the batch boxes, and the concrete was finished after puddling by means of an Ord tamper, and after belting and edging the slab was covered with wet burlap for the first night, and in the morning the burlap would be removed and calcium chloride spread on the surface to afford further curing. The actual mixing and handling of the concrete was done with the following force:

1 Foreman
1 Operator
1 Hoist man
2 Dumpers
1 Finishing machine operator
3 Puddlers
2 Finishers
2 Burlap and chloride men

With this organization and equipment, the contractor was able to lay 20 ft. Illinois Section pavement at the rate of 900 to 1,000 lin. ft. per 8 hour day, although sometimes a little overtime was necessary to reach that figure, from one cause or another.

**Bridge Construction.**—As already mentioned, the work involved the construction of a bridge over the Des Plaines River. This structure, similar to one erected at the same time about a mile to the South, and described elsewhere in this issue, was a skew girder type reinforced concrete highway bridge with Flemish bond face brick handrails, with a 44 ft. roadway and two 5 ft. sidewalks, designed for a uniform loading of 125 lb. per sq. ft. This bridge is supported by concrete piers and abutments, with concrete wing walls, resting on spread footings bearing on clay.

This bridge has a total length of 174 ft., with three spans. Essentially the same as the bridge downstream, it was built in 3 months and 4 days, with the exception of the handrail, a much shorter time than was required for the construction of the other bridge, built under the same conditions in general.

The contractor on this bridge used a very much simpler plant. In this case, the aggregates were dumped on the subgrade from motor trucks, at convenient places along the fill. On the same bank of the river, the west bank, a 2-bag Smith mixer was set up on a low platform and ramps laid to each side. The aggregates were taken to the mixer in wheelbarrows, and concrete was discharged directly from the mixer into buggies for distribution to the forms. Hollow tile were used as filler material under the sidewalk slabs. Piers and abutments were constructed after wooden cofferdams had been constructed on shore and towed to position and sunk in place. These cofferdams were constructed of 2x6 T & G lumber in 10 ft. lengths. Excavation was all done

by hand. Falsework to support the work was built up of pile bents, each carrying a load of 12 tons. A total crew of 27 men was required, including carpenters.

With this organization and equipment, the contractor could mix and place about 120 cu. yd. of 2,000 lb. per sq. in. 1:2½:4 concrete per day. It may be readily seen that the equipment charge against the job was done to the minimum, but that labor costs would be higher.

**Viaduct Job.**—The other important structure on the project is the new viaduct under construction to provide a grade separation at the intersection of the highway with the Soo Line tracks, about two miles west of the river. Here a general contractor and two subcontractors were found doing their work in an interesting manner.

The approaches to the actual trackage were excavated by a 31-B Bucyrus shovel loading into motor trucks and into Dump Trailers on crawler mountings, each of 8 cu. yd. capacity, and two hauled at once by a Caterpillar 60 tractor. This latter equipment, hauling with a round trip distance of about 1,000 ft., could make a round trip, thus moving 16 cu. yd. of dirt, in 17 minutes. Between trips of this crawler equipment, the shovel would load into the motor trucks. A La Plante-Choat hydraulic bulldozer mounted an a Caterpillar 30, served at the dump, making ordinary fill along the railroad.

**Hand Work Under Tracks.**—Since the work had to be done without interfering with the operation of the railroad in any way, different methods had to be used to remove the dirt under the tracks. Piles were first driven between the ties, and formed into bents by trenching in the ballast and spiking timbers from pile to pile, so as to form a trestle to carry the tracks. Eight drifts were then opened up through the dirt under the tracks, after the approach excavations had progressed sufficiently. These drifts were mined between bents by hand, with the men loading the dirt into wheelbarrows and wheeling it to the open excavation and dumping it over the edge. These drifts were widened to the piles, the amount of dirt being moved in this way being about 2,800 cu. yd. The balance of the excavation under the tracks was then done by dragline. After all excavation is completed, the viaduct structure will be built of reinforced concrete, and the railroad loadings then applied to the concrete upon the removal of the temporary pile bents. The cost of this viaduct will be shared between the railroad and the county.

**Those Responsible.**—The entire project was designed and built for the County of Cook, Illinois, under the direction of Maj. Geo. A. Quinlan, Superintendent of Highways, and W. E. Bates, construction engineer. The county was represented on the paving work by S. L. Winslow, resident engineer, and on the bridge by Robt. Hoffman, engineer and Joe Kane, inspector. The paving work was done under contract by the Chicago Heights Coal Company, represented by Thomas Peters, superintendent, while the bridge work was done by the Mohawk Eng. & Const. Co., contractors, represented by Swan Johnson, superintendent, and the viaduct work was done by the Great Lakes Const. Co., general contractors, represented by J. B. Shields, engineer, who sublet some of the work to H. H. Embody and Thomas McQueen, two well known excavation and grading contractors of the district.

The work was done under the standard specifications of the County Department of Highways.

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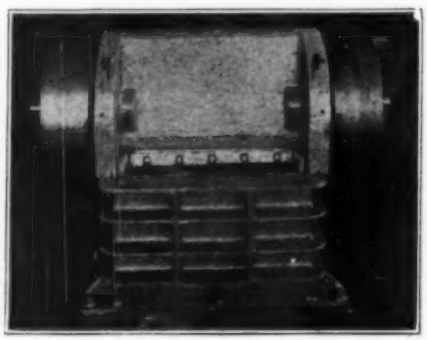
## A New Roller Bearing Wheeling Jaw Crusher

The Wheeling Mold & Foundry Co. of Wheeling, W. Va., who have been manufacturing jaw crushers for over 15 years, announce that they are now marketing a roller bearing jaw crusher, after months of experimental work and



New Roller Bearing Jaw Crusher

shop tests. Both pitman and main frame bearings are equipped with roller bearings, needing no adjustment.

Factory tests on hard granite and slag through a 9 x 36 crusher, weighing 10,270 lb., with hopper fully loaded, are stated to indicate less than 10 HP. actual ammeter readings. It also is stated that it was possible to turn the crusher freely by hand, and several large granite boulders were thrown in and actually crushed by turning the flywheel by hand. The roller bearing types are claimed to be practically free from vibration. The frame is a solid one piece cast steel structure as in the past. All jaws are manganese steel. Shaft is nickel alloy steel. Bearing construction is fool proof and dust proof. All parts are interchangeable. Regular equipment includes cast steel guard, wrenches and oil gun. The company manufacture the new crusher in four standard stock sizes, together with its regular line of bronze bearing crushers.

## Air-Rights and Tomorrow's Roads

Something new in highways is forecast in the announcement that Atlantic City and Philadelphia are to be connected by a $50,000,000 double-decked steel and concrete elevated roadway—construction to commence early this fall, according to "The Magazine of Business."

The roadway, said to be backed by the Pennsylvania railroad and other interests, will replace the electric lines now operating between the two cities, will be 70 ft. wide in two decks, and will have three traffic lanes in each. The electric-line tracks will be used for freight. The first deck of the roadway will be used by the railroad for a new high-speed gasoline and electric car.

The upper deck is to be used for automobile traffic. Tolls for the use of the road will also carry the right to use the company garage to be built in Atlantic City, the largest of its kind in the world.

This privately owned project for an elevated high-speed automobile highway is of special significance because of pending development of air-rights over railroad right-of-ways in many of the country's centers of population.

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**Bicycle Lanes on French Highways.**—According to H. C. Schuette, U. S. Assistant Automotive Trade Commissioner at Paris, France, the construction and maintenance of the numerous bicycle lanes ("trottoirs cyclables") that skirt the edge of a great number of French highways will be revived in the near future as a result of the new resources the Minister of Public Works is expected to divert to this purpose. The importance of repairing these lanes, long neglected because of a lack of funds, is measured by the fact that there are more than 7,000,000 of these vehicles in France, supplying the transportation needs of a large number of inhabitants. Realizing their need for repairs, the Touring Club de France has taken considerable interest in this work, and it is expected that construction of new "trottoirs cyclables" and the repairing of many old lanes will go forward very shortly. It is reported in France that the Minister of Public Works can use his own discretion as to what portion of the highways funds are to be used for this purpose. Although the Minister of Public Works can indicate the lanes which are in greatest need of repair, all maintenance and construction is in the hands of the chief highway engineers of each department, who are, in turn, under the supervision of the various state governments.

# Materials Testing Laboratory of Arizona Highway Department

## Organization and Equipment Described in Arizona Highways

By J. W. POWERS

Engineer of Materials, Arizona State Highway Department

IN the basement of the Adminstration Building at Phoenix—a well-lighted and spacious room—is the department whose business it is to supervise and test the materials going into the roads built under State specifications, and approved by the Bureau of Public Roads. On first entering this room one is confronted with as miscellaneous an array of machines as is found in a machine shop. Besides these machines, there are storage tanks, measuring flasks, boilers and other apparatus for carrying on tests. Ample apparatus is housed in the Materials Department to carry to completion tests on sand, gravel, cement, steel, asphalt, natural surfacing and other materials entering into road work.

In this connection a brief description of some of the most used materials in the state would be interesting. One is natural surfacing. A screen analysis to determine the percentage of gravel (material retained on a ¼ inch circular screen) and sand are made. From experience it has been found that material carrying from 10 to 40 per cent gravel not over 1¼ inch in diameter is most economical from the state's standpoint, and best riding from the public's standpoint.

**Cementation Test.**—In addition to the correct screen analysis, it is necesssary to have a binding agent to hold the sand and rock together, thus giving a hard and even wearing surface. This binding effect is determined by making what is known in the laboratory as a cementation test, a brief description of which is as follows: A small sample of the material passing a ¼ inch screen is ground in a ball mill with a known percentage of water. After grinding to a stiff plastic mud, it is molded into small briquettes. These briquettes are then dried and later broken under an impact hammer. The average number of blows required to break the briquettes is its cementation index. Experience has shown that a cementation index of less than 1200 gives a loose road, is hard to keep smooth under traffic, and has excessive wear. From this experience, materials which are sent into the Materials Department to be tested for surfacing are rated, and accepted or rejected on that basis.

**Strength Specification.**—Another is concrete. It is one of the most widely used of building materials and is the most facinating to test from the laboratory standpoint. The Arizona Highway Department at present is working under a strength specification; that is 6 in. by 12 in. test cylinders cast from the concrete poured on the job must show strength as follows:

| Mix | |
|---|---|
| Approx. | |
| 1-2-4 | ....2200 lb. per sq. in. at 28 days |
| 1-2-3½ | ....3000 lb. per sq. in. at 28 days |
| 1-3-5 | ....1700 lb. per sq in. at 28 days |
| 1-3-6 | ....1300 lb. per sq. in. at 28 days |

**Local Pits.**—As a very wide variety of sands and gravels are found in this state (there being very few commercial plants which are available for contractors' use) it means that if the contractor wishes to set up a plant on the job, and his materials conform to their individual specifications, they can be used, but not always in arbitrary mixes such as the long standard 1-2-4 (1 part cement, 2 parts sand, 4 parts rock by volume). To pour an arbitrary mix such as the 1-2-4 mix does not always insure workable concrete, nor concrete of the required strength. In such cases the material proposed for use is sent into the Laboratory for a suitable mix. The mix is designed from known data, and with the ever present knowledge to get smooth concrete in the field, it must be of such a consistency when placed that it will not produce honeycombing. Honeycomb in a concrete structure is very unsightly and connot very well be patched because it is almost impossible to match the originally poured concrete with any patching mix. The combination of strength and workability usually call for variations from the usual 1-2-4 mix.

What may be accomplished with a change in mix was amply illustrated on F. A. Projcet 90-A, in which the same kind of sand was used throughout but different rock. In one case a very harsh, crushed basaltic rock was used, in the other a comparatively smooth, crushed, limestone rock. Compressive strength in only one case fell below the standard set, and the use of cement was economical and the structure excellent. The yield on this Project was 6.1 sacks per yard, and the strength averaged 2950 lb. per square inch.

**Standard Methods.**—The United States Department of Agriculture at the time the Federal Aid Act went into effect, foresaw that to get uniformity in their results in the different states, they would have to lay down certain rules of procedure. This was done by publishing bulletins with the best known methods for testing at that time. Since that time they have published later bulletins in which revisions were made and are contemplating still another publication to take care of later revisions. Most of their methods of tests follow the American Society for Testing Materials' methods. The Arizona Highway Materials Department is a members of this Society, and has in its library the latest Standard tests. Specifications for material and methods of tests as written by the Estimating Department refer to A. S. T. M. Standard tests in many cases.

**A Local Research.**—The Department as yet is not in a position to do purely research work, but does attempt to keep abreast of the times. A small initial attempt at finding out the results of a worthwhile new method is noted below: In Phoenix, the City of Phoenix has been rehabilitating their old street railways system. A method of curing concrete new to this vicinity has been employed. The State Highway Department, always being interested in new methods, on invitation by the City, has been taking cores from this concrete to find out the efficiency of this method of curing under very extreme condition. To date, cores taken from this concrete and tested in the Materials Department have far exceeded expectations. So far only 7-day test specimens have been taken. When 28 days have elapsed on some of the concrete cured by this method, it is proposed to take more cores and thus have a complete check on the method. The method above referred to consists of spraying an asphaltic paint on the freshly laid concrete, no other curing being necessary. This does away with ponding methods and the nuisance of dust when at the end of the curing period, is allowed to dry and is cleaned off. Approximately 200 square feet is covered by each gallon of the asphaltic paint, or about the same spread one may expect from ordinary paint.

**The Library.**—The Materials Department is also a member of the American Concrete Institute and has their proceedings in their small library. As new books are published and more complete text books are brought out, it has been the policy of this Department to purchase them, the hope being that

at some future date a very complete reference library will be available.

The Materials Department works in conjunction with the Estimating Department on revision of specifications, making suggestions for changes, giving limits for gradings of sand and gravel, and other things which may come up from time to time. The estimating Department also uses the tests made by the Materials Department on samples submitted by the locating engineers on location, as a basis for an engineer's estimate of the cost of a job.

**Laboratory Routine.**—Testing in the Materials Department is carried on by the several operators, each doing his proportionate share. The procedure of a sample through the laboratory is as follows: On arriving at the laboratory the sample is stamped with the date, as it may be a day or two before work is begun on it. It is then given a Materials Department number and the identification card accompanying it, is attached to the laboratory work card. It now begins its rounds under this number through the different operations, and on completion is turned over to the Materials Engineer, where it is gone over and recommendations made. This information is afterwards typed and reports are sent to the field, the Bureau of Public Roads and the District Engineer. At the present time the laboratory is completing about 200 samples a month.

**In Conclusion.**—The Materials Department from its best judgment, experience and tests, tries to get the best materials for use on the State work.

## Brazil Builds Final Link in 1,200 Mile Road Between Cities

Thousand-mile tours by automobile in Brazil, a prospect undreamed-of a few years ago, are now a realty, according to Senor Godofredo M. de Menezes, representative of the Barzilian government, recently in Washington for conference with government authorities and officials of the Highway Education Board.

With the recent completion of an improved highway from Rio de Janeiro, the Brazilian capital, to Sao Paulo, capital of the Brazilian state by that name, it becomes possible, declares Sr. Menezes, to drive by automobile from Rio to Montevideo, the capital of Uruguay, a distance of approximately 1,200 miles. Sr. Menezes covered a large portion of this trip shortly before leaving for the United States. The only section of this road that is not built, he says, is an eighty-mile stretch off the coast of the state of Rio Grande do Sul, where the autoist must avail himself of the beach, at low tide, being afforded an excellent highway of nature's own construction.

While in Washington Sr. Menezes conferred with Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads and chairman of the Highway Education Board, and with Pyke Johnson, secretary of the Board and executive secretary of the Pan American Confederation for Highway Education, regarding the forthcoming sessions of the Second Pan American Congress of Highways to be held at Rio de Janeiro in June, 1929. The Brazilian authorities, he says, especially the president, Dr. Washington Luis, are looking forward to this conference as another opportunity still further to crystallize the growing interest in highway construction and highway transportation, not only in Brazil, but in all of Latin America.

By act of Congress at its last session, President Coolidge was authorized to appoint delegates from the United States to attend this conference.

Sr. Menezes also conferred with officials of the Department of State, the Department of Commerce, and the Pan American Union.

Highway construction in Brazil, according to Sr. Menezes, is under the supervision of Engineer Timotheo Penteado, who was a member of the first Pan American Highway Commission, a group of leading engineers, brought to the United States in 1924 by the Highway Education Board.

"President Luis," said Sr. Menezes, "is determined to open up the vast resources of our country by a network of modern highways. Two trunk lines totaling about 400 miles have recently been completed. This is but the beginning of an extensive road building program conducted under federal aid and supervision and supported by a special tax levied on gasoline and automobiles.

"The highway program in Brazil will greatly increase the opportunity for the sale of American automotive and road building machinery, and also should create additional markets for American products in the new outlying sections that will be opened up in this great South American republic.

"For this reason the forthcoming Pan American Highway Congress carries great significance to all American industry, in addition to those only interested in highway construction.

"The election of Dr. Luis to the presidency of the republic was the start of the construction of modern federal highways. One of President Luis' first acts was to obtain from Congress a law which would give him the means of carrying out the construction of federal highways. Work was begun on two principal trunk lines, one to connect the capital with all of the south, and the other to connect the capital with the north and center. The section from Rio de Janeiro to Sao Paulo already has been completed after overcoming almost insuperable difficulties of laying highways over lowlands of marshes and mangroves and through a hilly zone of more than 2,500 ft. above sea level."

The road from Rio de Janeiro to Sao Paulo is approximately 300 miles in length, and it is this stretch which formed the last link thus far constructed in the highway from Rio to the Uruguayan capital. Another road has been built from Rio north to Petropolis. In the near future this road will be extended to Bello Horizonte.

## 26,618 Killed in 1927 Highway Accidents; Increase of 1,316 Over Year 1926

Highway accidents took a toll of 26,618 lives during 1927, according to the American Road Builders' Association. The estimates include serious injury to 798,700 persons and an economic loss for the year totalling $672,097,000. The economic loss does not include minor damage to motor vehicles or accident insurance premiums.

The highway accident figures are based on an increase of 5.2 per cent over 1926. The American Road Builders' Association reported 25,302 persons killed in that year, in addition to 759,500 seriously injured. The increase of 5.2 per cent was shown in a progress report assembled by the Bureau of Census.

Grade crossing fatalities show a decrease for the first eleven months of 1927, the number of persons killed totalling 2,120 as compared with 2,244 for the same months of 1926. Grade crossing fatalities in 1926 had increased from 2,206 in 1925. The continued increase in the number of highway accidents has caused the American Road Builders' Association to renew its efforts toward bringing organizations interested in the problem into closer co-ordination.

"The unfortunate increase in highway accidents makes imperative an immediate adoption of uniform traffic codes, and an expansion of the nation's road building programs," officials of the association declared. "The human factor is the main element contributing to these accidents, but that human factor could to a large extent be offset by adequate motoring facilities and regulation, coupled with the individual practice of courtesy and caution."

**Bridge Program in New Mexico.**—A report on the bridges built in the first six months of this year by the New Mexico state forces, exclusive of contract work, shows that a total of 25 bridges have been completed while extensive repairs were made on 6 others. These structures ranged in size from a single 21 ft. span of untreated timber to multiple span creosoted timber and steel girder bridge. The fall and winter will see many more such jobs complete with 7 bridge crews at work.

# Bridges on Califonia State Highways

## Development in Art Described in California Highways and Public Works

By C. E. ANDREWS
Bridge Engineer, California Division of Highways

IT has once been said that no objects in America more greatly mar the landscape than the bridges, and none in Europe are more attractive. This perhaps was true of a great portion of the older bridges constructed in America, particularly so of railroad bridges. The condition can be attributed largely to the following causes:

Lack of artistic training in engineers, limited resources, competition and haste in construction, undesirable or unsymmetrical location, inadequate materials, absence of state or municipal supervision.

It is gratifying, indeed, to know that the age which designed for strength alone is past, and the principal hindrances, as above mentioned, no longer stand in the way of building, in America, bridges that are most attractive and at the same time most adequate. In fact, an era of higher ideals in bridge designing has been assured in creating the necessity of having specialized and well trained men to do this work.

**California Problems.**—As to the general bridge situation in California, the problems confronting the department are of rather vast proportions. As mentioned previously a large percentage of bridges now existing on our highways were built by the counties. As time passed these structures were gradually taken over by the state until in 1925 practically all of those which were of acceptable design were taken over for maintenance. The enormous increase in traffic both as to volume and weight, of which you are all aware, has very greatly compliacted the general bridge situation.

Many, in fact the larger per cent of the bridges built by the counties were for much lighter loading than is now considered adequate. The roadways are necessarily much too narrow for the vastly increased traffic volumne. The alignment in many cases is dangerous. These statements are not in any way made as a criticism on past practices. Not only California but every state in the Union has done likewise and nearly all are confronted by the same problem.

Engineers generally could not forsee the effect that the automobile would have. Nor did they have the money to provide for the increasing requirements even though some might have been able to predict the future. In many cases, then as well as now, it was, and is, economy to build not too far into the future if in so doing it is necessary to invest too large an amount of money.

**Future Developments.**—We must all admit that even though we have in the last ten or fifteen years experienced the greatest transformation in the traffic requirements in history, it is still conceivable that still greater developments will occur.

The fact remains that we now have the large number of light, narrow and poorly aligned bridges and one of our hardest problems is to decide whether we should widen and strengthen our existing structures accepting a certain amount of overstress and its attendant inferiority or entirely remove or relocate and build new structures which will adequately take care of present and future traffic as we are able to predict it.

**The Flood Problem.**—We find that often the problems of what to do about the present structures is much harder to solve than the design and construction of an entirely new structure. The bridges are widely distributed over more than 6,000 miles of state highway in all conceivable sorts of climate and conditions. Foundations involve the worse and best conditions from solid rock to silt 200 and more feet deep. On many streams it is hardly conceivable to one uniformed why a bridge 2,000 feet long should be spanning nothing but sand or brush, and sometimes it is hard for an engineer to convince himself that it should remain so. Floods, however, become very convincing if one waits long enough.

It is probable that no other state has localities which are subject to more erratic or unexpected floods, all of which tend to complicate the bridge question.

There now exists on the state highway system between 1,500 and 1,600 bridges of over 20-ft. spans. Almost all types of structure are among these as well as almost any degree of physical condition. Their combined length is approximately 42 miles and their combined cost approximately $30,000,000.

**Bridges From the Layman's View.**—It is, perhaps, safe to say that the strongest appeal modern highway bridge engineering has for laymen comes from the bold, spectacular structures which the scenic highway routes have made possible, and of which routes California has her due share. The more rugged and mountainous the country is, the more often such opportunity is presented and economically justified for constructing an attractive bridge. Against ill adopted structures in alignment and unsightly in appearance, perhaps constructed at an early date, and located in sections of the country which have little charm, suggest slight appeal of the profession to the layman, and only impress him with a feeling that a touch of a trained hand or service of a specialist is required in the fitting of a bridge to the needs of a highway.

**Bridges From the Engineer's View.**—Bridges and their construction appeal to engineers on account of the many engineering problems involved.

First and foremost is the problem of financing. Will a slight change in alignment giving a better but more expensive bridge be justified, and how wide should a bridge be constructed to take care of the heavy increasing traffic, are questions to be answered.

The investigation of foundation conditions is very important in order that the proper and best adapted materials will be selected for a bridge at any given location. The investigation of foundations should be so thorough that no change in type of foundation should be required after construction is under way. In selecting type of bridge, and kind of materials, it is important to take into consideration the climatic conditions in order that the structure will have a long life and will require a minimum amount of repairs and upkeep.

Investigation of the amount of opening for this waterway to provide unobstructed flow requires that a careful study be made as to the area of the water shed, the amount and rapidity of run-off. Structures built to offer obstructions to flow during extreme high water often cause scouring of channel that endangers the structure or approach roads.

In selecting the kind of material a bridge is to be built of, concrete, steel, timber, treated or untreated, etc., it is important that no oversight is made in figuring the cost of raw material at its source, cost of transportation, cost of erection, painting, finishing and upkeep.

Records showing life of bridges, with cost of upkeep, are important so that the type of bridges built from year to year will give a maximum value for the money invested.

Complete plans and specifications that will insure against extra work being required after a contract is let are very important, and it will invariably save considerable money, although adding slightly to the cost of preparation of the plans.

When all of the foregoing is prop-

erly complied with, it is only the first step, for in order to get a good bridge it is necessary to construct it properly which requires rigid inspection and proper testing and placing of materials.

**Ideal of Good Bridges.**—It is the hope of the bridge engineer that the finished structures will be durable, pleasing in appearance, conform to the canyon or stream; so that both laymen and engineer will gain the impression that bridge construction is being kept abreast with building of modern highways.

## Photograph of Construction Work

**From the Construction Manual of the State Highway Department of Minnesota**

A photograph record shall be kept of all classes of construction work, pictures being divided into two classes, construction and scenic.

Construction pictures shall be taken of road sites or of any technical piece of work, be it roadway or structures. Special attention shall be given any feature that might lead to difficult construction or where a dispute is liable to arise. Pictures shall be made of the terrain at these points, giving all the detail possible. Pictures shall be taken before, during and after construction at the same location.

The pictures shall be of a minimum size of 3¼ by 4¼ with a glossy finish, and three prints shall be made of every negative. One print shall be for the photographic record book, one for the resident engineer, and the third with the negative shall be transmitted at once to the central office with a notation on the back of the picture giving the following information:

State project, section, F. A. P.
County, station, direction.
Date of picture.
Descriptive remarks.

Scenic pictures shall be taken only of the finished work. These pictures are for the use of the publicity department, and shall be taken to secure a general view of the terrain with the road as a part but without trying to show any details of the construction. These pictures shall be of a minimum size of post card.

If necessary, a photographer may be secured to get good scenic pictures. If taken by a photographer, the pictures shall be not larger than 4 by 6, having a glossy finish and a border ½ in. in width. Four prints shall be made of all scenic pictures, one for the record book, one for the resident engineer, and two prints with the negative, with complete descriptive information shall be submitted to the central office at once.

The photographic record book shall be of letter size, using a three-ring loose leaf binder furnished by the Central office. The picture shall be filed on the right hand page on only one side of the sheet. Separate loose leaf sheets shall be inserted opposite the pictures, which should contain the descriptive data, given above, relative to each picture. The pictures on each sheet shall be only of that one location, showing the different stages of development and shall be inserted in chronological order from top to bottom.

The photographic record book shall be completed and turned in with the final records of the job. The following title shall be placed on the cover of the book:

All pictures turned in to the central office shall be sent to the office engineer. All expenses relative to the securing of the pictures will be taken care of on expense account or by monthly invoice.

MINNESOTA HIGHWAY DEPARTMENT
PHOTOGRAPHIC RECORD
of
S. P. No..... Sec..... F. A. P.....
Located between..... and.....
County of.....
Nature of work.....

## Survey Party Supply List

**Guide for Survey Parties for Thirty Day Tour Duty Away From Base of Supplies**

Not all survey parties on state highway work have the opportunity of working near enough to a town to take up quarters there. They must then maintain a camp. This smacks of the old days of railroad surveying. The field manual of the New Mexico State Highway Department suggests the following list of equipment and supplies as a guide in outfitting parties for the field. However, the engineer should be governed by the distance from the base of supply, and other conveniences. Do not purchase supplies for a period of more than one month, and at the time that camps are moved engineers should endeavor to have only such supplies on hand as will enable them when the new camp is reached to await the arrival of a new supply.

1 Transit with stadia hairs and vertical arc or circle.
1 Wye or dumpy level.
1 Abney level or clinometer.
2 Hand levels.
3 100 ft. steel tapes.
1 Tape mender.
3 12 oz. plumb bobs.
2 Steel line rods ⅝ in. by 6 ft. and ⅝ in. by 8 ft.
1 Wood range pole ¾ in. by 10 ft.
1 Philadelphia level rod 13 ft. extension.
Black crayon (use only black and never red).
Stakes (lath can be used on preliminary).
Stake sack.
Hub tacks.
8 lb. hammer.
Gad for making holes in hard ground.
Axes.
1 Hand axe.
Set of drafting instruments.
Protractor.
2 Triangles 10 in. or 12 in.
12 in. Engineer's scale.
Drafting table.
3 in. Earth auger for soundings.

The list given is for 16 men for 30 days. The amount ordered should of course depend on the number of men.

Allspice, 1 lb.
Evap. apples, 30 lb.
Apricots, 1 case.
Bacon, 50 lb.
B. P., 10 lb.
Beans, 50 lb.
Beef, fresh.
Beef, corned, 1 case.
Beef, dried.
Blackberries, 1 case.
Oats, rolled, 25 lb.
Butter, 60 lb.
Candles, 10 lb.
Catsup, 6 large bottles.
Honey, 5 gal.
Hominy, 15 lb.
Kerosene, 5 gal.
Lard, 50 lb.
Lemon Extract, 6 oz.
Nutmeg, 2 oz.
Matches, 2 cartons.
Milk, 2 cases.
Mustard, 1 lb.
Onions, 50 lb.
Peaches, 1 case.
Peaches, evap. 25 lb.
Cheese, 25 ib.
Cherries, 1 case.
Coffee, 50 lb.
Corn, 1 case.
Cornmeal, 100 lb.
Cornstarch, 10 lb.
Crackers, 20 lb.
Eggs, 1 case.
Flour, wheat, 500 lb.
Flour, graham.
Fish, mackerel.
Soap, laundry, 30 lb.
Fish, cod.
Raisins, 20 lb.
Ham, 150 lb.
Tea, 3 lb.
Vinegar, 1 gal.
Peas, 1 case.
Pepper, black, 2 lb.
Pie fruit, assorted, 2 cases.
Pickles, 3 gal.
Potatoes, irish, 300 lb.
Prunes, evap., 25 lb.
Salt, 10 lb.
Salmon, 1 case.
Sauce, pepper, 3 bottles.
Sauce, Worcestershire, 6 bottles.
Sugar, 150 lb.
Syrup, N. O., 5 gal.
Tapioca, 5 lb.
Vanilla Extract, 6 oz.
Yeast cakes, 1 lb.
Stock 18 lb. grain per head per day.
30 lb. hay per head per day.

The above is taken from the records of a grading camp. Saddle stock will probably require less hay.

## Depreciation of Construction Equipment

One of the most interesting reports to be presented at the 1929 Convention of the American Road Builders' Association, will be that of the Depreciation Committee. This committee is headed by W. A. Van Duzer, Assistant Chief Engineer of the Pennsylvania Department of Highways and representing state highway interests. The membership of the committee is made of representatives from all factors of the highway interests as follows: Chas. E. Grubb, county; H. C. Whitehurst, city; Ward P. Christie and S. M. Williams, contractors; B. F. Devine, manufacturers; John Alden Grimes, Internal Revenue Department; W. H. Rastall, Department of Commerce.

The report of this committe will be presented at the Engineers' Session on January 16th and will include—A study of depreciation of construction equipment as it applies to contract and maintenance work. A resume of the Associated General Contractors' report. Three methods of charging off depreciation, first—unit of time basis—charging off so much depreciation for each hour, day or month used; second—unit of work basis—charging off depreciation according to the work done; third—contractors' equipment or job method. This report will also contain a list of equipment showing the percentage of depreciation, and suggested rental rates on construction equipment.

# Swamp Road Construction

## Practice in Louisiana Described in The Highway Magazine

By JOHN J. MUNDINGER
Principal Assistant Engineer, Louisiana Highway Commission, Baton Rouge, La.

THIS article will discuss some of the peculiar problems that have to be solved in the construction of highways in the Louisiana lowlands. An interesting feature of wooded swamp and alluvial sections of Louisiana is that the ground surface immediately adjacent to the streams is higher than the land further to the rear. Consequently, the higher land has been most highly developed homes, settlements, villages and towns being established on the "front." To serve local interests of the greatest numbers, highways are generally constructed along the banks of these streams. But as these streams in most cases run almost parallel to each other, it is in the construction of the "cut-offs" or cross highways that swamps are encountered.

**Swamp Roads.**—Before a swamp project is placed under construction, it is necessary to make, in addition to the usual surveys and investigations, a comprehensive investigation covering all conditions to be encountered. This survey covers depth, type, and location of muck strata; and location, depth and type of clay or other material available for use in the embankment. Borings are taken at close intervals, generally to a depth of 27 to 30 ft. From this information the desired cross-section of the roadway and the depth of the canal are fixed.

The roadway embankment over a swamp is generally constructed with large floating dredges, of either the dipper or clam shell type, the size varying with the requirements of the job. Dredges of 5 to 7 yd. capacity, carrying booms from 150 to 235 ft. in length, are frequently used.

The operation consists of digging the material for the embankment from one side of the proposed roadway, a canal being thus formed. The width and depth of this canal varies according to the size of the dredge and the material encountered. All unsuitable material such as stumps, muck and decayed vegetation classed as stripping or waste, is spoiled on the opposite side of the canal, and the suitable sand or clay deposited in the embankment.

To construct successfully a dredged embankment across a deep swamp having a large amount of muck material, requires placing the embankment in two or more layers, allowing each layer to dry out and become solidified. The rough embankment after being allowed to stand for several months is then dressed to final grade and section, generally by means of a crawler-type dragline and by a heavy blade grader. When the embankment has stood sufficiently long, it is then surfaced with reef oyster shells, clam shells, gravel or a combination of these materials.

Owing to the impracticability of widening roads of this type in the future, it is necessary, or at least desirable, to anticipate traffic demands years in advance. It is, therefore, the present policy of the commission to construct swamp road embankments wide enough to carry four lanes of traffic when subsequently paved, with 5- to 10-ft. shoulders in addition. Bridges, except large structures crossing major streams, are built the full width of the roadway, thus eliminating the "throttling in" of traffic at these points.

**In Prairie Marsh.**—In the southern and southeastern portions of the state, fringing the Gulf and the lakes, is found the Prairie Marsh section, varying from 10 to 20 miles in width, famed as the hunter's "paradise" and the trapper's "El Dorado." This section alone produces more fur in value than Canada and Alaska combined, according to recent reports.

In order to reach Gulf resorts and hunting and fishing grounds, and to furnish short connections to large centers of population, it has been necessary in some instances to cross these marshlands with standard highways. Marshland—if land it can be called—varies greatly in character, depending on the locality. In the southwestern portion of the state, the marsh is generally firm, being underlaid with good sandy clay; during dry weather cattle graze on it. In other sections the marsh is mostly muck, consisting of decayed vegetation, varying in depth from 1 to 20 ft. It is this type of marsh that presents difficult problems that must be solved before a highway can successfully be constructed over it.

The same detailed investigations and surveys are made for this class of construction as for the inland swamp work. It is necessary to determine in advance if enough suitable material is obtainable at economical depths along the roadway, or whether material must be transported from a distance.

Highway embankments are of three general types: dredged fill, transported fill, and pumped-in hydraulic fill. The dredged embankment construction in the marsh differs little from the dredged embankment construction in the swamp. Less stripping or waste is required in marsh work but the shrinkage factor is considerably greater, the canal excavation running 2 to 4 times the net embankment section.

In certain marsh sections the overlying muck is of such depth as to make it impracticable to obtain suitable material from a dredged canal along the roadway; the canal thus formed would be of prohibitive depth, causing sloughing, subsidence and other loss of placed material. In such sections the ground surface usually drops abruptly from the pine hills to the deep marsh.

When such conditions are encountered, the embankment is constructed with material transported by rail in side-dump dirt cars. A temporary filling trestle is first constructed along the centerline of the project. The embankment material is loaded in the cars by power-driven excavators, and is then hauled and dumped from the trestle. While this type of construction is costly, it eliminates entirely the element of chance, and results in a completed roadway in a much shorter time than required for dredging the embankment, even though dredging were considered feasible.

**Hydraulic Fill Construction.**—Numerous lakes and streams separate sections of Louisiana from the Gulf Coast winter and summer resorts. Most of the highways across the intervening marshes has been constructed by the dredged embankment method.

However, where the located line of a marsh road parallels the shore of a lake or stream wherein suitable material can be found, the embankment is usually constructed by the hydraulic method. A suction pump is mounted on a barge, which, with its operating machinery, is placed in the lake or stream at successive advantageous points. The material is pumped to the road through a 12- to 30-in. pipe line. The discharge, 80 to 90 per cent water, runs off rapidly, leaving the solid material in the embankment. The dredges can pump economically through from 2,400 to 3,200 ft. of pipe without booster pumps.

It is customary to have a single pipe line along the center of the fill, extending it section by section as the fill advances. In some instances two lines are employed, one along each shoulder line. This is thought to be the better method, as two levees can be built simultaneously; after the parallel levees are constructed for a distance of 500 to 1,000 ft., the two lines are replaced by a single line which builds up the embankment between the levees, the water running off ahead leaving a slope of about 20 to 1.

The fill is brought to a true grade by the use of bleeders. These are 2-in. holes, 8 to 10 ft. apart, in the main pipe line, which are closed with wooden plugs and opened when desired to allow sand and water to pass out, thus building up the low spots.

Even though the material be very sandy, side slopes 2½ or 3 to 1 can be obtained by the novel method of using ridges of hay or grass placed parallel with the line of the embankment. The water passes through the grass but the sand is checked and deposited. As the material builds up, successive lines of grass are placed nearer the line of dischage so that, when finished, the embankment has the appearance of having been built in steps. Green or dry marsh grass, which is easily cut with an ordi-

nary scythe, serves excellently for this purpose. Unless the sand slopes are thus controlled they will assume a slope as flat as 30 to 1.

The most noteworthy characteristics of a highway embankment built hydraulically are its immediate and uniform compactness, its very small subsidence (due to its unusually wide base), its adaptability to beautification, its safety factor (inherent in its method of construction), and its being "ready for traffic" at once.

# Material Required by Unit Volume of Concrete

To the Editor: In your August issue there was an article by Mr. A. H. Hunter entitled "Material Required by Unit Volume of Concrete." This subject is one of interest to all concerned with the making of concrete.

There are certain differences between Mr. Hunter's conception and my own of the influence of aggregate characteristics. In the interest of a better understanding, friendly comments seem to be in order. I hope my remarks will be taken in the amiable spirit intended.

Much of the article is devoted to the influence of voids on concrete yields. Aggregates affect yield only through displacement. Specific gravity and weight of dry material tells how much solid matter (absolute volume) is present and this is the yield contribution. Subject to a slight correction for absorption, the voiding happens to be the complement of the absolute volume for the simple reason that it is what is left.

If footnote to Table I is correct it is evident that in a 1:2:3½ mix 2 cu. ft. of sand and 3½ cu. ft. of rock must be used for each sack of cement. Naturally, the requirements per cubic yard must be in the same ratio. Thus, if 1.61 bbl. (6.44 sacks) are required to the yard of concrete, 6.44 times these amounts must be the true quantities of sand and rock in cubic feet. Division by 27 converts them into decimals of a cubic yard.

Below is an adaptation of author's Table I, the cement being shown in sacks and bracketed figures representing the only mix ratios that could possibly produce such figures:

| | 30% | |
|---|---|---|
| Cement, sacks | 5.96 | (1) |
| Sand, cu. ft. | 11.34 | (1.90) |
| Rock, cu. ft. | 20.25 | (3.40) |

It is evident that these mix ratios are something else than 1:2:3½.

The discussion concerns voids but does not clearly indicate whether the author means voids in both aggregates or in rock alone. By trying out all possible combinations and seeing how they matched up with cement factors shown it finally became clear that he meant rock voiding to be the only variable. This was standardized on 40 per cent voiding in both aggregates and the amount of water figured which would build up to a yield of 4.19. In the other columns the amount of water and the sand displacement were kept constant. For dry loose sand 40 per cent voiding is about right. If he is not talking about dry loose sand the graph shown in the article lacks meaning.

Let us take the 40 per cent voiding case. Absolute volume of the cement is 0.49. Assume that water of absorption is supplied (and then ignored in further calculations). The absolute volume of the sand is 1.20 and the rock 2.10. This requires the presence of 0.40 cu. ft. of free water to give a yield of 4.19. The absurdity of this is that with 3 gal. of water you would have an Abrams curve "A" strength of 6,500 lb. but such a mix would be too dry to handle. However, this is the only set of facts which matches his cement requirements. The following table gives the basic figures:

| | 30% | 40% | 45% | 50% |
|---|---|---|---|---|
| Cement | 0.49 | 0.49 | 0.49 | 0.49 |
| Sand | 1.20 | 1.20 | 1.20 | 1.20 |
| Rock | 2.45 | 2.10 | 1.92 | 1.75 |
| Water | 0.40 | 0.40 | 0.40 | 0.40 |
| Yield | 4.54 | 4.19 | 4.01 | 3.84 |
| Bbl. per CY | 1.49 | 1.61 | 1.68 | 1.76 |

Unless the sand voiding and the water amount are considered constant there is no earthly way of checking his figures. A revision of Table I follows:

| | 30% | 40% | 45% | 50% |
|---|---|---|---|---|
| Cement bbl. | 1.49 | 1.61 | 1.68 | 1.76 |
| Sand cu. yd. | 0.44 | 0.48 | 0.50 | 0.52 |
| Rock cu. yd. | 0.77 | 0.83 | 0.87 | 0.91 |
| Cement per cent | 92.55 | 100.00 | 104.35 | 109.32 |
| Sand per cent | 92.55 | 100.00 | 104.35 | 109.32 |
| Rock per cent | 92.55 | 100.00 | 104.35 | 109.32 |

It should be explained that the quantities shown above are by the measurement of actual proportioning. In the case of rock this should be about the same as the origin measurement by which it is usually bought. In the case of sand the relation to origin measurement is uncertain. For sand loaded directly from washing into railway gondolas and so measured, the above sand quantities could be reduced. The extent of such reduction is largely a matter of local conditions.

The second part of his table was obtained by dividing his erroneous aggregate quantities by the wrong basic figures credited to Taylor and Thompson. His cement percentages are correct with one exception which is an outright mathematical error. Taylor and Thompson bears about the same relation to enlightened concrete practice that Godey's Lady Book does to current fashions.

| 40% | | 45% | | 50% | |
|---|---|---|---|---|---|
| 6.44 | (1) | 6.72 | (1) | 7.04 | (1) |
| 12.15 | (1.89) | 12.69 | (1.89) | 13.23 | (1.88) |
| 20.25 | (3.14) | 22.41 | (3.33) | 23.49 | (3.34) |

He states that equipment is available for the practical use of inundation methods but if you were to inundate 2 cu. ft. of sand having 40 per cent voiding it would need 0.80 cu. ft. of inundation water and his table could not apply. The fact is that the one place above all others where the inundator is taboo is on highway mixes of strengths below 3,000 lb. and the dryer consistencies.

He said that moisture bulking has some effect on coarse aggregates. For the sizes generally used on highway work it has practically none.

He explains that "some states are now using measurement by weight with frequent daily changes due to variation in voids, moisture and other factors." It is hardly clear how the percentage of voids (per se) can call for any quantity adjustment when proportioned by weight nor how it can affect yield. It may affect cost but even this trouble disappears when materials are bought by the ton.

The balance of the paper is of practical rather than scientific import and its only relation to material requirements is due to the patent fact that x plus $\Delta x$ is greater than x.

As to his concluding sentence it might be pointed out that the true physical yield is precisely determinate when the facts are known and the survey of these facts in skilled hands is not difficult. Any bright youngster with a fair grasp of high school physics can be taught this part of field technique in a few hours.

Rather than the God-help-us tone he might have pointed out to contractors that any large operator will find that a well paid engineer thoroughly posted on concrete matters can more than "pay his way."

W. M. HOLM.

# Special Exhibits at the Road Show

Many exhibits presented by foreign governments will be on display at the 1929 Road Show of the American Road Builders' Association. The nations of South and Central America have been invited to send exhibits to the meeting.

The Bureau of Public Roads is planning the most elaborate exhibit which that organization has ever presented. Already a number of the draftsmen and artists in the bureau are devoting their time and talents to designing the booths to be filled by the bureau. The exhibit will be held under the direction of H. S. Fairbank.

Invitations have also been extended to the State Highway Commissions throughout the United States to present exhibits at the convention and it is expected that a large number will participate.

It is interesting to note the improvements that are being made from year to year in road construction and maintenance practice throughout the country. These improvements will be set forth in the special exhibits at the 1929 convention which will undoubtedly be one of its outstanding features.

# Road Oiling

## Recent Progress in Western States Outlined in Colorado Highways

By WALTER N. FRICKSTAD
Highway Engineer, U. S. Bureau of Public Roads

THE subject of bituminous oil treatment of fine crushed rock and gravel roads, with its promise of not only conserving material, but improving service to the public, has attracted such attention that it falls into discussion whenever a small group of western highway authorities gather together.

**The Work in Oregon.**—During 1927, Oregon, the western pioneer in the recent revival of interest in bituminous treatment, extended treatment of its highway system by 380 miles to a total of 950 miles. The surface method was used generally, but a series of experiments was undertaken as described hereafter. Oregon now has roads of this character more than four years old and has full confidence in their durability and usefulness.

The tendency in Oregon in 1927 was toward a heavy road oil for the second application, which involved a thicker covering of stone chips and brought less complaint from the traveling public concerning damage to automobiles driving through fresh oil. It is difficult to appraise the merits of these modifications until the end of next summer. The prophecy is ventured that the roads will not be as smooth as when treated with light oil exclusively, but the amount of repairing may be substantially reduced.

**Other Western States.**—California in 1927 treated approximately 600 miles of road. Both methods, surface treatment and oil mixing, were used, apparently with equal confidence under the respective appropriate conditions. Some of the work was placed upon important highways and was frankly temporary in nature, but has been eminently successful.

California is now undertaking some oil plant mixing projects as described below.

Utah and Nevada during 1927 were added to the states undertaking oil treatment, the former with 30 miles and the latter with 5 miles. The work was in excellent condition in the middle of the spring, and its behavior during 1928 will be observed with great interest.

Idaho, which had previously used the surface method, undertook oil mixing upon 70 miles. Reports to date show excellent results.

Wyoming "oil mixed" one long project with Wyoming asphaltic oil. The highway department, having had rather unsatisfactory experience with paraffin base oils, is preparing to observe the condition of the recently treated project during the summer before undertaking an extended program.

Colorada is putting in sixteen miles of the penetration type of oil road this year, while New Mexico already has laid twelve miles and has another stretch of ten miles under construction.

All of the other states in the western region have indicated an interest in the use of bituminous oils, and with one or two exceptions, are planning to begin or continue this type of work during 1928. Many county highway organizations and a few cities are also planning similar work.

**Experimental Work in Oregon.**—The experimental work in Oregon alluded to above has to do with heavy road oil and heavy tar. Three types were tried, classified by the highway department as "skin coat," ¼-in. to ⅝-in. in thickness; "penetration," ½-in. to 1⅜ in. in thickness, and a "road mix," ¾-in. to 2½ in. The two methods first listed are efforts to solve the old problem of applying a thin coat of heavy oil and stone chips to a previously constructed roadway.

The Oregon "penetration" is similar to methods applied with great success in Riverside and San Bernardino Counties on concrete, and sometimes upon gravel. Careful selection of material and the most expert, painstaking supervision and workmanship have been found necessary in these counties. It is one of the most difficult classes of oil treatment.

The third class of experiments in Oregon, designated as "road mix," differs from the work of the same name in California, in the use of clean crushed rock with fines removed and the use of heavy road oil (90-95 per cent) or heavy gas tar. A prime coat is first applied to the base, the coarse aggregate is added, and the principal application of oil is spread. The rock and oil or tar are then mixed with a blade grader until the rock is well coated. The material is then spread and rolled, a seal coat applied, a small quantity of fine chips spread, and the whole then rolled again. In some cases an additional application of oil with more stone chips has been added. The result resembles penetration macadam, but the methods are quite different from those generally accepted. The blade mixing is not different in principle, however, from the harrowing which was commonly done in California between applications of oil in the earlier days of that type of construction.

The cost of work like that in Oregon can only be estimated, as the experimental sections were too short to furnish reliable data. A report by the Oregon state highway department, which describes the work in detail, estimated the respective costs as follows:

Thickness, ⅜-in. skin coat, cost per square yard, 10 ct.; ¾-in. mat, 20 ct.; 1½-in. mat, 35 ct.; 2¼-in. mat, 55 ct.

**California "Old Plant Mix Wearing Surface."**—California has specified and awarded contracts on what may well be called an "old plant mix wearing surface." The largest project of this character is 118 miles on the Coast Route between Santa Monica and Oxnard. The project now stands graded and the contract provides for laying a temporary surface 24 ft. wide, part of which will be 4 in. thick, compacted measurement, all of fine crushed rock mixed with oil. The remainder will have 3 in. of oil-mixed material on a 3-in. fine crushed rock base. It is assumed that paving will be required shortly, and this described surface is purely for the purpose of carrying traffic while the earth is consolidating. The significant items of the contract are: 42,000 tons of fine crushed rock at $2.79 per ton; furnishing 8,000 bbls. of medium grade fuel oid at $1.50 per barrel, and mixing 34,000 tons of surfacing material at 35 ct. per ton. The contract prices are fairly balanced but are well below the engineer's estimate. For mixing the material the engineer estimated 55 ct. per ton, and bids ranged from 25 ct. to 43 ct. The contract price for mixing only is approximately $1,000 per mile for a 24-ft. roadway and 7 ct. per square yard for 3-in. or 4-in. compacted thickness. Reduced to 2 in. of compacted thickness and 18-ft. width, the prices would become 4 ct. per square yard and $420 per mile. If the material were mixed on the road, the cost would range from one-third to two-thirds of the foregoing amount, and the spreading of the oil would add something more. It may, therefore, be said, if these prices are representative, that plant mixing costs $150 to $200 per mile more than road mixing for an 18-ft. surface 2 in. thick. The uniformity of the plant mixture, a quality difficult to obtain under present field methods, may well justify that much extra cost.

**The Field for Oil Treatments.**—The traffic on projects already treated varies so widely that there may be some confusion as to the appropriate field within which oil treatment should be used. Some projects are carrying several thousand vehicles per day. It is true that the width of surface on these projects is generally greater than the normal two-lane width, but it should be emphasized that treatment under such heavy traffic was undertaken as a temporary or emergency matter, usually to furnish service to the public during the period of consolidating fills.

One of the first projects treated by the mixing method was in the Imperial Valley, where the excessive traffic had destroyed much of the surface material. To add to the difficulties, the subgrade was in many places poorly drained. Oiling was undertaken to save what rock remained and to carry traffic until funds could be gathered for more substantial construction. The expected has happened in that an appreciable percentage has broken and the maintenance costs have been rather high. The

state's course in this emergency is beyond criticism, but the case illustrates that oil treatment is not a magical process in lieu of satisfactory subgrade and adequate thickness of rock. Until the contrary is demonstrated by several years of observation, the normal field for oil treatment, aside from emergencies, is that heretofore held by fine crushed rock or gravel. Research has indicated that the limit of traffic for the economical construction and maintenance of fine crushed rock ranges from 300 to 600 vehicles per day, in arid or semi-arid territory, depending upon the character of the stone and binder, and perhaps runs as high as 1,000 vehicles per day for ideal material in humid territory. It would seem wise to apply the same limits to oil-treated roads for the present, remembering, however, that climatic influences are reversed.

On the other side of the story, what is the minimum traffic that justifies oil treatment? The answer depends upon the cost of the treatment as against the unit value of the untreated material destroyed by traffic; also upon the consideration we should give to purse and comfort of the vehicle operator. Is oiling justified when traffic reaches 100 vehicles per day, or should the figure be 250 or more? Should we undertake any new project without making provision for oil treatment? These questions need not be answered definitely until more roads carrying heavy traffic are treated, but thought must soon be given to the subject.

In deciding whether a given project is adequately installed for oiling, width of surface is one of the factors. It has been said that oiling should not be attempted upon a surface less than 18 ft. or 20 ft. in width. This is undoubtedly a good working rule.

## Heavy Accident Toll in Pennsylvania Claimed by Autos

Motor vehicle accidents in Pennsylvania totalling 2,387 are responsible for the deaths of 48 persons and injury of 1,930 during the month of July, the accident report section of the Pennsylvania Department of Highways has reported to James L. Stuart, Secretary of Highways. July figures bring the total for 1928 to 365 killed, 9,772 injured and the grand total of accidents to 13,811.

Direct collision with pedestrians resulted in 18 deaths and 370 injuries during July. Collisions of motor vehicles with each other caused 19 deaths. The deaths resulted from collisions with horse drawn vehicles; seven from collisions with fixed objects and two from non-collision accidents; collisions of motor vehicles with each other caused injuries to 6,325 persons.

Pedestrians lead with a 3-to-1 ratio for the year with 201 deaths from direct collision, automobile collisions claiming a toll of 68.

Analysis of the accidents involving motor vehicles shows, among other things, that 2,252 drivers had more than a year's experience, that 364 were on the wrong side of the road, 252 did not have the right of way and 279 were exceeding the speed limit, at the time of accident. Nearly half the total number of accidents occurred on comparatively straight stretches of highway while curves or hills were also contributing factors. In 130 instances accidents resulted from cutting in, favorite practice of drivers who pass cars without sufficient clearance of opposing traffic.

**Dangerous Period.**—Sunday continues to lead in accidents with 590, eleven of them fatal. From 4 o'clock to 6 o'clock in the afternoon remains the heavy accident period of the day with a total of 443, eleven of them fatal.

The 48 deaths for the month began with five tots under four years of age, followed with 12 children from 5 to 14 years, 20 persons from 15 to 54 years and nine over 55, with no age stated in two cases.

Street intersections rank near the top in location of accidents, with 653 accidents for the month resulting in six deaths. Pedestrians continue to exhibit a penchant for darting into the traffic stream from between parked cars, leaving the operator no chance to see them until too late to avoid a mishap. Three pedestrians met death while crossing the street between corners.

Secretary Stuart, commenting on the accident report, said:

"Two lessons are to be drawn from an analysis of July accidents. The first is that more than one-half of the drivers involved in accidents have had more than a year's experience. It seems that during the first year the operators of motor vehicles take care to avoid accidents and being successful, they assume that their increased experience renders them immune from accident and are more apt to be careless.

"The second lesson to be drawn from this heavy toll of accidents is that a great many of them could be avoided if drivers exercised prudence in driving on or near dangerous points of the highways and if they had exercised courtesy toward their fellow drivers. The Sunday accident toll illustrates this fact more vividly than others."

**Courtesy Needed.**—"My observation in European traffic, especially in England, is that courtesy is outstanding in practice. There the driver of slow moving vehicles consider the driver in his rear as well as in front and signals him forward when the road is clear. On our own highways only a few truck drivers observe the clearance ahead and then signal following vehicles to pass. The same thing is true of those driving new cars or enjoying the scenery along the highway at a low speed while a line of cars collect at the rear.

"The number of street intersection accidents also strikingly emphasize the need of care and courtesy when approaching street crossings. While it is true that automobilists should take care not to endanger lives and limbs of pedestrians, the latter owe a duty to the automobilist, too. They should not rush out heedlessly from behind or in front of parked cars nor should they carelessly dart across the streets between points of intersection.

"I don't believe I am extravagant when I say that the practice of courtesy by drivers and pedestrians would immediately cut down this horrible accident total by 30 to 40 per cent," Secretary Stuart concluded.

## Moving a 30-Ft. Finishing Machine on Trucks

An interesting method of moving a 30 ft. asphaltic concrete raking and finishing machine was employed by a California contractor. We are indebted to California Highways and Public Works for the following details.

Specially constructed for raking and finishing asphaltic concrete surface mixture for the full width of 30 feet this machine was necessarily heavy. During operation its entire weight is carried on car wheels running on the side forms as a guide or track. To secure rigidity in the frame of such a wide machine, it is necessary that the transverse members of the frame be rigid steel trusses. Except by driving by its own power on a 30-ft. gauge track moving this machine would appear to be a job for special equipment.

The contractor, Mr. Steel Finley, found that the job could easily be done with two of the dump trucks he uses for hauling the asphaltic mixture from the plant to the highway. Operation number one was to roll the machine by its own power on planks laid temporarily under the wheels to a position parallel with the highway. When the machine was turned to this position, dump trucks were backed to each end of the machine with bodies raised as for dumping material. A heavy chain was passed across the rear end of each dump body and fastened to the end of the machine. The dump bodies were then lowered to hauling position. Due to the slightly forward position of the hinges this caused a raising of the extreme rear end of the dump bodies thereby lifting the finishing machine from the ground. The remainder of the moving was a matter of team work of the two truck drivers, one driving forward and the other backing, both moving at the same speed. At the end of the move, the operation was reversed and the finishing machine returned to its working position across the highway.

The machine was moved a number of times during the progress of the contract.

# DISTRIBUTOR NEWS

## *The Distributor's Department in the Gillette Construction Group*

### Our New Department

With this issue DISTRIBUTOR NEWS, the new department in The Gillette Construction Group of magazines greets the distributor and the manufacturer's representative. Following the Gillette policy of rendering the best possible service to our readers and advertisers, this department has been established to give prominence to the individual and trade news concerning the distributor.

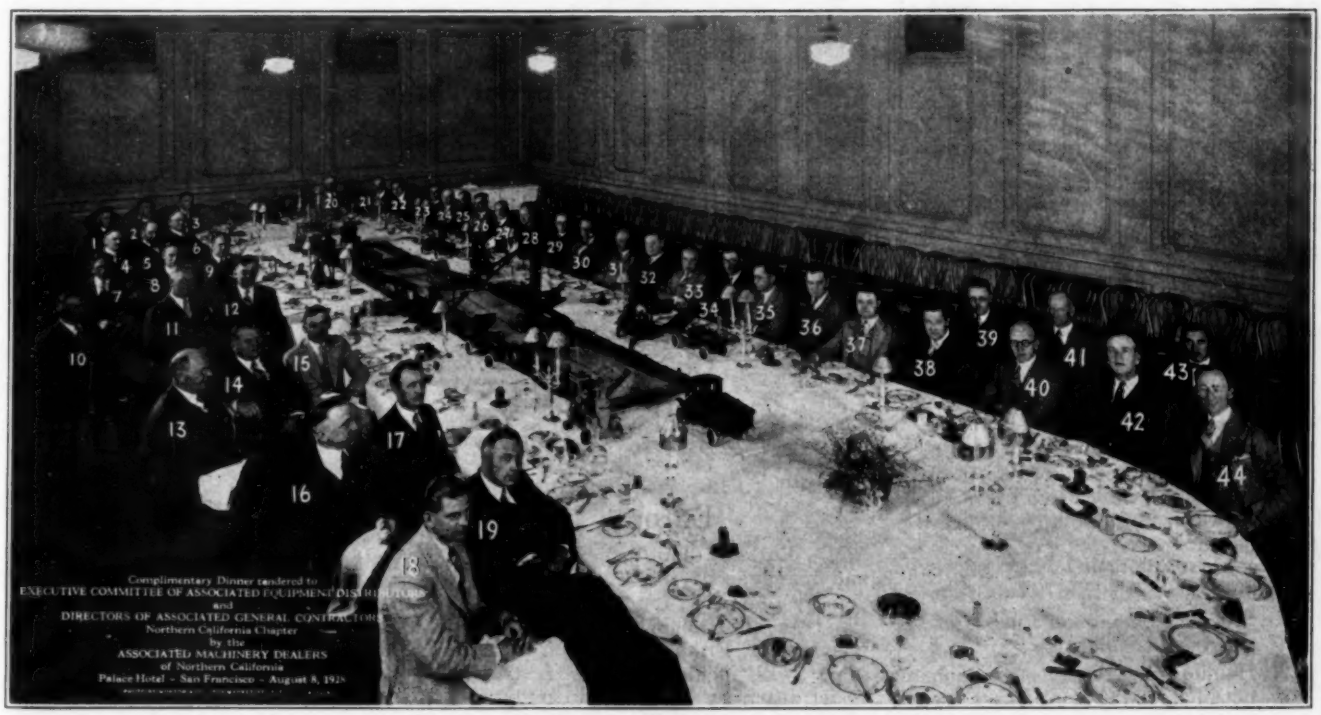
It is our purpose to present in these pages (which will be found in every issue hereafter under the title given above) topics of interest to the distributor as they may relate to the manufacturer and contractor in the various fields which the Gillette publications cover.

We have named the department DISTRIBUTOR NEWS because it is all inclusive. Under this heading we hope to present news of all kinds as it pertains to this field. Space will be given to selling, shipping and service methods as they contribute to the growth of business and the promotion of goodwill competition.

The equipment user may think of the factory as the whole source of supply, whereas, due to the efforts of the distributor working with the manufacturer, machinery and repair parts are distributed throughout the entire country where the operator can obtain them on the shortest notice. Who the distributor is, where he is and how he renders service are a few points to be looked for in DISTRIBUTOR NEWS.

We should like to hear from our friends throughout the country with suggestions for these columns. If you have questions which you would like to have other distributors answer, send them in and we will run a Question Box to take care of them. Illustrations of warehouses, improvements, or pictures which tell a story will all be welcome. Photographs, too, will be used when for some reason someone is entitled to a special introduction to the readers of DISTRIBUTOR NEWS. These pages belong to you, let us hear from you. Communications for this department should be addressed to The Editor, DISTRIBUTOR NEWS, Gillette Publishing Company, 221 E. 20th St., Chicago.

# Distributors Discuss Equipment Credits at Conference




**Members and Guests Present at Banquet in the Palace Hotel**

Distributor News in October Engineering and Contracting carried a story of the semi-annual meeting of the Executive Committee of the Associated Equipment Distributors which was held in San Francisco, Aug. 6 to 11. For those of our readers who did not see that issue we present again a picture of the banquet at which this committee and the Board of Directors of the Northern California Chapter, A. G. C., were the guests of the Associated Machinery Merchants of Northern California. The banquet was held in the Palace Hotel. We wish we might have seen this table with its unique center piece, a replica of a paved road and construction equipment in miniature.

## The Bacon Bible

An odd sounding title to find a place in DISTRIBUTOR NEWS, and we hasten to inform our readers that we have not gone in for collecting old editions.

The Bacon Bible is a little booklet put out by Edward R. Bacon Company of San Francisco and telling the story of the distributor in one of the most attractive and interesting ways that has come to our attention. It is printed on ordinary wrapping paper, each page having a colored border, the edges being staggered to the center and then starting back the other way. The cover carries a pen sketch of Sir Francis Bacon. The reading matter is made up of quotations from this classic writer followed in each instance by the modern application of the quoted precept in the words of Mr. Edward R. Bacon. The center spread is given over to trade names and equipment handled by the Edward R. Bacon Company. The booklet contains no illustrations, and Distributor News will let Mr. Bacon tell you why:

*"They are ill discovered that think there is no land, when they can see nothing but sea."—Sir Francis Bacon.*

"Which means: You'll find nary a picture of our stuff in the whole book. The printer said he couldn't do justice to our fine items on this kind of paper, so we left the speaking likenesses of 'em out to suit him. Anyway, when you drop in to see us, you'll see the machines themselves—in actual operation—and that's better than the best oil paintings we could paint of 'em. Anyway, we can't paint."—Edward R. Bacon.

Distributor News also was impressed by Mr. Edward R. Bacon's way of stating Sir Francis on **Truth.**

*"No pleasure is comparable to the standing upon the vantage ground of truth."—Sir Francis Bacon.*

"That's a bible in itself. All we've got to say about that is that we never have to remember a word of what we've said about any item we sell: that means we start telling the truth about it and keep it up. That way you can't catch us on any claim we can't back up."—Edward R. Bacon.

In a broadside sent out by this company they state their creed as follows:

1. Study the equipment needs of the construction industry.
2. Handle only the finest equipment obtainable to meet those needs, and to earn profits for the user.
3. Sell such equipment at reasonable prices, quality considered, and upon terms that are fair to the purchaser, his fellow contractors and ourselves.
4. Honestly service this equipment when in use.

## Giving City Officials the Air

When city officials are "given the air" it is not always so pleasant as it proved to be in this instance. During the annual convention of the League of Kansas Municipalities held recently in Kansas City, the Butler Manufacturing Company of that city and Minneapolis offered free airplane rides as prizes to the visiting city officials. The rides were awarded by drawing the names from a box.

The plane used was owned by the Butler Manufacturing Company, and is the one used by them in consulting with city officials on the arrangements of airports and Butler Steel Hangars and Steel Buildings. The following are the names of the lucky officials, who in most instances took their first air-ride with Lieutenant Rodenbaugh:

John Pomeroy, city clerk of Holton.
H. E. Rodgers, city clerk of Ottawa.
R. W. Mitchell, commissioner of finance of Ottawa.
Fred Knapp, city clerk of Topeka.
Fred J. Evans, mayor of Garden City.
W. K. Snyder, city clerk of Bucklin.
Glenn Young, commissioner of finance of Herington.
A. H. Dyck, water superintendent of Hillsboro.
C. H. Kerr, mayor of Independence.
H. D. Cory, commissioner of finance of Leavenworth.
Roy F. Kennedy, commissioner of public utilities, Ft. Scott.
H. N. Sowers, chief of Fire Department of Atchison.
W. E. Lacey, mayor of Mildred.
I. E. Kirkland, Kansas City.
J. W. Pettet, Kansas City.
J. A. Caron, Mildred.
H. T. Bonar, Kansas City, Mo.
Mary Bybee, League of Kansas Municipalities, Lawrence.
Albert Martin, Lawrence.


**Airplane in Which the City Officials of the Kansas Municipalities Were Given a Ride. The Man in the Picture Is Lt. Elmer S. Rodenbaugh, the Flying Representative of the Butler Manufacturing Company**

## Enroute

Mr. Earle S. Phillips, vice-president and manager of the Good Roads Machinery Company, Inc., Kennett Square, Pa., is on an extended trip to the Pacific Northwest. From that section the itinerary will include the entire Pacific Coast territory with a return by way of the southern route.

Mr. Phillips is making this trip to intimately study conditions in the various sales territories as relating to the products of the company, and visiting the direct representatives and dealers who represent the company from coast to coast.

The products of the Good Roads Machinery Company include rock crushers, elevating, conveying, screening and washing equipment. Complete sand and gravel producing plants, motor graders, hot oil distributors and a very complete line of snow plows for attaching to motor trucks.

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**The Jenison Machinery Company** located at 50 Fremont Street, San Francisco represents the merger of the Northern Division of the **Smith-Booth-Usher Company** and the **Stuart S. Smith Company.**

## Distributor Notes

**The National Machinery & Equipment Company** reports a very nice business in their territory on ½ cu. yd. shovels and "55" Tractors, and are anticipating a continued demand for this type of equipment. This company is the representative in its territory for the following manufacturers:

Mead-Morrison Manufacturing Company, East Boston.

Austin Machinery Corporation, Muskegon, Mich.

Ohio Power Shovel Co., Lima, Ohio.

Edwards Manufacturing Co., Albert Lea, Minn.

Bay City Foundry, Bay City, Mich.

Hardsocg Wonder Drill Co., Ottumwa, Iowa.

The Pierce Governor Co., Anderson, Ind.

The Erie Machine Shops, Erie, Pa.

The Buhl Company, Chicago.

Mohawk Asphalt Heater Company, Schenectady, N. Y.

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**The Walter A. Zelnicker** Supply Company of St. Louis announces the appointment of Mr. Spencer S. Swasey of Chicago as manager of the Equipment Department. Mr. Swasey was for twelve years with the Geo. D. Whitcomb Co. (manufacturers of Whitcomb Locomotives), the last six of which he was in charge of sales. This experience coupled with three years of contracting at the head of his own company, should provide a valuable background for contractors and others doing business with the Zelnicker Company.

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**The New Orleans Equipment Company** of which Mr. Clifford H. Stem is president and general manager, is one of the large distributors of machinery, equipment and automotive supplies located in the south. Their large warehouses carry a stock of practically all of the equipment for which they are distributors. They have a force of traveling salesmen as well as men experienced in the erection and demonstration of the machinery. This company is located at 400 Jackson Avenue, New Orleans.

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**The Erie Steel Construction Company** announces the opening of a Chicago office for the sale and service of Erie Aggre Meter Plants and Erie Clamshell Buckets. Mr. O. H. Watson is the engineer in charge and is located at 231 Engineering Building, 205 E. Wacker Drive. Mr. Watson is prepared to handle with promptness all requiries and questions on steel bins, volumemetric and weighing aggremeters, clamshell buckets, overhead traveling cranes and complete storage yard installations.

## W. A. Riddell Company Holds Sales Conference

The W. A. Riddell Company recently held a three-day Sales Conference at Bucyrus, O., where their general offices and factories are located.

The entire sales force, with one exception, was present. Arrivals, making acquaintances and renewing friendships occupied the first morning. After lunch the men made a tour of the factory, and later films showing Warco road machinery in operation were exhibited.

At 6:30 the salesmen were invited to the Elks' Club, where they were guests of the company at a banquet. Mr. Geo. M. Schmidt, general manager, read a communication from Mr. Riddell, the president, wherein he expressed regret

Mr. N. E. Jersey, Newly Appointed Sales Manager

at his inability to be in attendance, but declared himself as being back of every salesman 100 per cent. Mr. Schmidt then introduced as toastmaster the new sales manager, Mr. N. E. Jersey. Mr Jersey has served the company as designing and experimental engineer, chief engineer of track and grader department, and as sales engineer. His appointment, Aug. 1, as sales manager filled the vacancy occasioned by the resignation of Mr. R. O. Perrott. Mr. Jersey introduced representatives of the collection, accounting, credit, sales, advertising, roller, scoop, track and grader departments, all of whom gave the salesmen an insight into their particular problems.

Factory inspection and witnessing of manufacturing operations, occupied the second morning. The afternoon was given over to testing and demonstrating Warco road machinery on the proving ground near the company's south shop. In the evening the salesmen banqueted the officials and department representatives, and sponsored by Mr. Jersey, presented their side of the story.

The last day was spent in conferences with the credit and collection departments, and with individual sales conferences. After dinner an informal conference of the round table type was the order of the evening; it resulted in a closer understanding of each others problems by salesmen and home office representatives, alike. The conference was most successful, and the salesmen are enthusiastic over the plans of the company and the future outlook of Warco road machinery.

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### President Radiator Company Enters Reserve Air Corps

Fred M. Young, president of the Young Radiator Company of Racine, Wisconsin, has accepted a commission of captain in the Specialist Reserve, Air Corps, U. S. Army. Mr. Young served as aeronautical engineer and pilot with the U. S. Air Service during the late war, both in this country and overseas, and his return to the Air Service Reserves marks his continuance of interest in this work with which he has kept in constant contact through his work in the automotive engineering field.

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### A Word From The Bond Company

The Bond Company, dealers in tools and equipment for construction work, located at 84 High St., Boston, report 1928 to be by far their busiest and most successful year. They attribute this in a good measure to the excellent lines of equipment which they have been handling, as the service given by the equipment which they sell makes friends and repeat orders for them.

Distributor News quotes the following paragraphs from a very interesting letter recently received from The Bond Company:

"Perhaps the most interesting feature of the year has been the number of heavy trailers we have sold for moving power shovels and other heavy machinery. The almost universal use of caterpillars has made it impracticable to tow equipment of this sort along the road without the use of a trailer, and, of course, freight shipments involve the expense of loading and unloading as well as considerable uncertainty as to time of arrival.

"When we sell a trailer we make it a point to inform all the contractors who own shovels in that vicinity that so and so has purchased one of our trailers and would like opportunities to help keep it busy by moving their shovels at so much an hour when they have moves to make. In this way our customers soon build up a profitable rental business which enables the trailer to pay for itself very quickly."

The Bond Company handle Smith concrete mixers; Insley chuting equipment and excavators; Northwest shovels and cranes; Novo engines, pumps and hoists; Ingersoll-Rand compressors and Rogers gooseneck trailers.

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**American Tar Products Company** announces that their Nashville representative, Mr. J. M. Lewis, has changed his address from 3713 Central Avenue to 1708 Villa Place.

## New and Larger Quarters

In the October 1st issue of California Constructor just received by Distributor News two pages are devoted to the story of the growth of the Brown-Bevis Company, which Distributor News presents in condensed form to its readers.

This company is now ranked among the largest distributors of construction equipment in the United States. The new building is located at 49th and Santa Fe Avenue, Los Angeles. It is one story high, of concrete and brick construction and occupies a space 430 x 130 ft. with a yd. in the rear 200 x 137 ft. It is divided into a sales room and office 230 x 130 ft., and a shop and parts department 200 x 120 ft. It is paved with 5½ in. reinforced concrete. The yard is equipped with a spur track and overhead traveling crane with a capacity of 12½ tons. The craneway is 400 ft. long extending from the spur track to the far end of the machine shop thus permitting machinery to be lifted from railroad cars and placed at any point, under the fifty foot crane span, in the open yard or within the machine shops.

The story of the growth of this business concerns the lives of two young men of modest means, of serious purpose, and a desire to provide a complete line of construction machinery for the building industry of Southern California, in which industry by years of experience they had gained a wide knowledge. Starting with an office and some used machinery, Brown-Bevis Company, by careful selections, within a short time represented many manufacturers of national reputation. To insure prompt deliveries they rented a warehouse and small sales room on Third Street. The expansion of the construction industry in Southern California necessitated the purchase of the Madsen Iron Works, in order to comply with their creed of service.

In 1927 Mr. D. G. Bevis retired from the firm, which was reincorporated and Mr. Dan R. Brown made president, and it was this new corporation that decided, in the interest of service and economy, on the expansion which resulted in the new building described in the opening paragraph. In speaking for himself as president and his associates in the Brown-Bevis Company Mr. Brown says: "Most business grief is caused by failure to anticipate problems and it was in anticipation of the continued growth of all lines of business in California that we have built and moved into our new location."

**Mr. C. Philip Dearman** has recently been appointed exclusive representative for M. V. Hendricks Company of Morenci, Mich., and the Chausse Oil Burner Company, Elkhart, Ind. Mr. Dearman's territory will include Illinois, Wisconson and the northwestern portion of Indiana. Distributor News is glad to present Mr. Dearman to his fellow distributors. His Chicago office is located at 105 N. Clark St.

## In Point of Age

**The Joe Lyons Machinery Company** of Little Rock, Arkansas, claims the distinction of being the oldest dealer in contractors' equipment in the State of Arkansas. They deal exclusively in machinery and supplies for the road and building contractor, the quarry man, and the sand and gravel companies. In stock they carry a complete line of parts for all the equipment which they handle, and render night as well as day service to the contractors where such service is necessary.

In building up their business over a long period of years they have made a point of getting the opinion of contractors before taking on a new line, usually putting a machine out with a contractor to be tested before definitely deciding to represent the line.

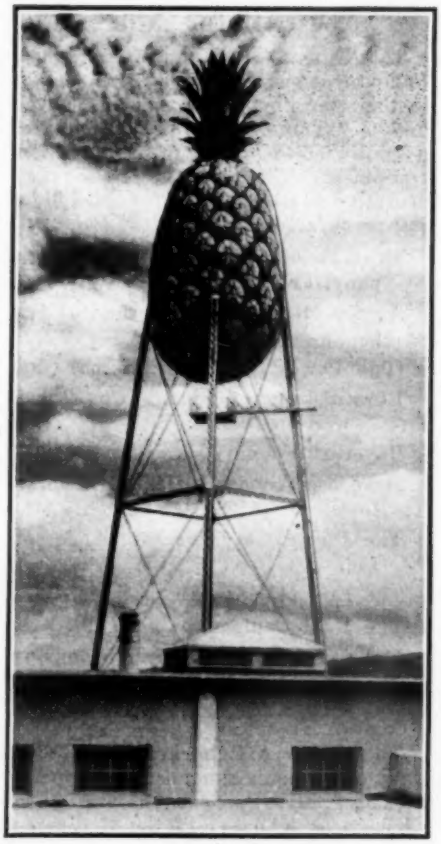
As the first equipment dealers in the field they have had a wide range of manufacturers to choose from. At the present time they are representing the Rex mixers and pavers; Ingersoll-Rand air compressors, etc.; Blaw Knox bins, batchers and road forms, curb and gutter forms, etc.; Bucyrus-Erie shovels, cranes and draglines; Morrow washing and screening plants; Allis-Chalmers crushers, etc.

A Glimpse Into the New Warehouse of the Brown-Bevis Company

### Steady Growth

Interstate Machinery & Supply Company of Omaha, Neb., started in business over twenty-seven years ago with power transmission machinery, roofing materials and a jobbing machine shop. They now have the following distinct departments: Power plant and water works equipment; contractors' equipment, mill supply and factory equipment, auto replacement parts and machine tools, and the jobbing machine shop. Including their shop employees, they have nearly one hundred men on the pay roll. They have ten salesmen traveling in the western part of Iowa, all of Nebraska and a portion of South Dakota. They also use a number of specialty men, and each department of their business is in charge of a competent manager.

This company reports an increase in business over 1927 with indications for a greater increase in 1929. In the tractor field they represent the Monarch Tractor Corporation, a subsidiary of the Allis-Chalmers Company.



Elevated Water Tank, Fabricated in the Greenville, Pa., Plant of the Chicago Bridge & Iron Works, and Erected in Hawaii by That Company's Forces. It Stands on the Property of the Hawaiian Pineapple Company at Honolulu in Plain Sight from Waikiki Beach and Advertises the Company's Product. It Is a Steel Structure, Even the Leaves of the Pineapple Being Cut from Steel Plates and Riveted in a Cluster. It Has a Capacity of 100,000 Gal. of Water

## Recent Appointments

**The Trackson Company** of Milwaukee, manufacturers of Trackson full-crawlers, loaders, shovels, etc., for McCormick-Deering Tractors, announces the appointment of the following companies:

For the Far West

B. Hayman Co., Inc., Los Angeles.
O. R. Peterson Co., Inc., San Francisco.
Polson Implement Company, Seattle, Wash.
Zimmerman-Wells-Brown Company, Portland, Ore.

For the South

Dealers Equipment & Implement Co., Memphis, Tenn.
Evans Implement Co., Atlanta, Ga.
F-D Equipment Co., Dallas, Texas.
Industrial Tractor & Equipment Corp., Richmond, Va.
Industrial Machinery Co., Kansas City, Mo.
Southern Equipment Co., Inc., New Orleans, La.

These companies are also handling repair and replacement parts for these machines and are prepared to give prompt service on all orders.

## Asphalt Paving Conference to Be Held at New Orleans

Conflicting meeting have made it necessary to move forward the date for the Seventh Annual Asphalt Paving Conference to be held this year in New Orleans and, accordingly, the meeting will be held during the week of Dec. 3rd instead of that of Dec. 10th, as previously announced. The technical sessions will continue for three days, beginning on Tuesday, Dec. 4th, and continuing until Friday, Dec. 7th, when the conference will close with a golf tournament and the award of a number of handsome prizes to the winners. An exceptionally interesting and informative program of technical discussions and novel entertainment features have been provided. The Association of Asphalt Paving Technologists, The Asphalt Association, and the local committees are cooperating to make this conference even more successful than the six which have preceeded it.

For the first time in the history of the conferences, asphalt paving at airports will come in for thorough discussion. Among those who are expected to participate in the airport session are William P. MacCracken, assistant secretary of commerce in charge of aeronautics; Col. H. H. Blee, engineer for the Aeronautical Division, Department of Commerce, and several consulting or construction engineers prominent in the work of designing and building commercial and municipal airports.

The program will also present new and far-reaching economic and technical questions of vital importance to the good roads movement. The vast possibilities in the surface treatment of the many hundred thousand miles of roads that constitute the secondary highways of the country will be dealt with from the economical, technical and practical construction standpoint by a selected group of authorities headed by E. W. James, chief of the Division of Design, U. S. Bureau of Public Roads.

Radical strides in the development have been made recently in the mechanical equipment and operations involved in the construction of asphalt pavements and in the technique of asphalt construction, and these developments will be presented by men who have first-hand knowledge, including T. Warren Allen, chief of the Division of Control, U. S. Bureau of Public Roads; M. H. Ulman of the Pennsylvania State Highway Department; Prevost Hubbard, chemical engineer of the Asphalt Association, and others of equal authority and prominence.

Remarkable service results in the use of asphaltic concrete (black base) in California have induced the attendance of one or more prominent engineers from that state to present the results of their experience to the conference. Chris P. Jensen, county engineer of Fresno County, California, one of the best authorities on this type of construction in the United States, is expetced to present his experience with this type of paving.

Another feature of importance from the standpoint of practical firsthand information will be a series of papers by the heads of various state highway departments telling what results they have obtained with all forms of asphaltic construction and surface treatment. Seven of the states which have had wide and useful experience along these lines are Massachusetts, Michigan, Louisiana, Tennessee, North Carolina, Georgia and California, and also the Province of Ontario.

The first day, Monday, will be devoted to registration and committee meetings. On Monday evening there will be an open house reception arrangement. Light refreshments will be served. The reception committee will see that everybody becomes acquainted and there will be a few entertainment features to liven up the evening. Tuesday will be devoted to the opening morning session followed in the afternoon by a boat ride and inspection trip on the Mississippi River and Lake Ponchartrian, with the New Orleans Refining Company as host. The asphalt technologists will meet in the evening. On Wednesday there will be morning and evening technical sessions and the afternoon will be devoted to a specially conducted trip to the race track where the Standard Oil Company of Louisiana will be host to those attending the convention. On Thursday there will be morning and afternoon technical sessions. During the day a special social function is arranged for ladies, consisting of a luncheon with a talk by Dorothy Dix, and a trip through the French quarter of New Orleans. Thursday evening there will be a carnival ball with the Mexican Petroleum Corporation as host. This ball will be a replica of one of the famous Mardi Gras balls and will be held at the Athenaeum. The City of New Orleans will provide special street lighting and special details of police and firemen for this event. On Friday will be held the golf tournament.

A very strong local committee on arrangements has been created with John Klorer, New Orleans city commissioner of public property, as chairman. Mr. Klorer has charge of all paving for the City of New Orleans. He is also vice-president of the American Society of Municipal Improvements and is an outstanding figure in municipal work in this country.

The local sub-committee chairmen assisting in the arrangements are as follows: Committee on Entertainment Features, T. Semmes Walmsley, commissioner of public finance, City of New Orleans; Committee on Reception and Welfare, William T. Hall, commissioner of public utilities, City of New Orleans; Committee on Official Contact, Paul B. Habans, commissioner of public safety of New Orleans; Committee on Transportation, Watler Jahncke, president, Jahncke Service, New Orleans; Committee on Publicity, Harold Wright, aide to Mayor O'Keefe; Committee on Registration, Sam Fowlkes, manager, New Orleans Convention Bureau; Ladies' Committee, Mrs. George Penrose; Committee on Golf Tournament, Thomas Taylor, sales manager, Standard Oil Company of Louisiana; Committee on Special Features, (1) Carnival Ball, W. R. Wilkinson, for the Mexican Petroleum Corporation; (2) Boat trip, L. M. Law, for the New Orleans Refining Company; (3) Race track party, H. C. Ehrenfels, for the Standard Oil Company of Louisiana.

A national engineering committee, upon which will appear the names of some of the foremost engineers in the United States, is being constituted under the chairmanship of Maj. J. M. Fourmy, State Highway Engineer of Louisiana. A research committee is also being formed with W. J. Emmons, Associate Professor of Civil Engineering, of the University of Michigan, as chairman. The presonnel of this committee will be selected by the Association of Asphalt Paving Technologists of the United States and Canada, of which Mr. Emmons is first vice-president.

Presiding officers at the various sessions will include chairman, State Highway Commission of Louisiana; J. N. Holder, chairman, State Highway Board of Georgia; Capt. H. C. Whitehurst, assistant engineer commissioner of the District of Columbia; John M. Mackall, chairman of the Maryland State Road Commission, and others.

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## Sand and Gravel Production Continues to Increase

The production of sand and gravel in this country in 1927 amounted to 197,454,269 short tons, valued at $115,529,786, according to the United States Bureau of Mines, Department of Commerce. This was an increase of 8 per cent in quantity and of 4 per cent in value as compared with the large output of 1926, and was chiefly due to the increase in paving and roadmaking sand and gravel and railroad ballast.

The sand production was 93,588,339 short tons, valued at $54,291,398; gravel production was 103,865,930 short tons, valued at $61,238,388.

New York led all the states in sand and gravel production with 19,896,766 short tons, valued at $12,157,612. Illinois was second, its output amounting to 19,328,703 short tons, valued at $9,166,934, and Michigan was third, with 15,419,499 short tons, valued at $7,800,541.

About 76 per cent of the total production of sand and gravel was reported as washed and screened.

# Snow Removal Equipment Useful for Clearing the County, State and Federal Road

## Equipment That Will Be Supplied by Manufacturers for the Coming Season

THE WINTER of 1928-29 will soon be upon us. In 36 states of the Union and throughout the Dominion of Canada, state and county officials will be called upon to keep the roads clear of snow throughout the heaviest snowfalls, or at least to clear the way after the storm has ceased, in order that buyers may reach the merchants' stores in the cities that the children may attend school without inconvenience, in order that supplies can continue to be delivered without hindrance, and in order that all sorts of traffic may be kept on the move. A municipality with a recognizable rural trade will find it to its interest to insist upon keeping the roads open that lead to the community, in order to keep this desirable trade that would otherwise cease altogether during the period of blockade, or be diverted to a more far-sighted community that could be more easily reached. The task will fall to county and state, and will be insisted upon by the communities of the state.

While the cost varies widely with the amount of snow to be removed, the snow removal equipment used, and the methods and management brought into play, it will be found that the cost is an investment well worth while, an investment that will be repaid ten-fold.

While costs and methods and management will be largely discussed in a later issue of Roads and Streets, the information in the following pages will afford state and county authority a good picture of the types of equipment that will be found available this season for snow removal work, and will indicate the ways in which the various machines have been used to good advantage.

**Baker Snow Plows.**—The large line of Baker Snow Moving Equipment manufactured by The Baker Mfg. Co. of Springfield, Illinois, includes both "V" and blade types. Snow plows are made for attachment to leading tractors and standard motor trucks. Among the many models, are the well-known Patent Trip Blade Snow Plows for motor trucks which permit use on pavements likely to contain obstructions such as man-hole covers, car tracks, etc. When the blade strikes the obstruction it swings back and, upon passing, trips back instantly thus not injuring truck or plow. These blades are in sections of about two feet wide. Other models include snow plows for McCormick-Deering and Fordson tractors up to those for Five-Ton, thirty, Ten-Ton and sixty. The heavier plows are hydraulically operated. Special speed plows both "V" and blade type have been developed for use with motor trucks employed at great speeds. In every Baker Snow Plow there is evidence of a desire on the part of the manufacturers to make snow plows of unusual strength, a snug fit on the truck or tractor and the maximum of convenience in its operation.

A Baker Plow Mounted on a Commerce Motor Truck

**North Hydraulic Digger.**—The North Hydraulic Digger, manufactured by the W. M. Blair Mfg. Co., 3673 Michigan Ave., Chicago, Ill., is designed to lift piled snow from the street, in loads of one cubic yard, and elevate and dump this snow into a motor truck or dump wagon. The lift is 90 in. This machine is said to be capable of loading from 300 to 500 cu. yd. of snow per day. In the summer the same outfit is used for digging and handling other material.

The power unit of this machine is the Fordson tractor, and the digger can therefore be operated by anyone who can operate the Fordson. Only one man is needed in its operation. The tractor is equipped with rubber tired wheels for this service, for operation on city streets. The lifting action is accomplished by means of a hydraulic hoist at the front of the tractor.

**Barber-Greene Snow Loaders.**—There is often a special case or two on a state-maintained or county-maintained

A North Hydraulic Digger Loading a Motor Truck on Snow Removal Work

road where a snow loader will fit into the picture very well, such as in the case where the road passes through a built-up section outside of a city.

Comparative figures show that a snow loading machine will do the work of 50 to 200 shovelers, that it will work tirelessly day and night, that it costs very much less, and that it is remarkably faster. It is good business to use snow loaders.

There is no longer any need to put up with the delays caused by snow, because it can be removed quickly by modern machinery. Barber-Greene Snow Loaders, manufactured by the Barber-Greene Co., Aurora, Ill., have been used successfully for eight seasons in the largest cities in the country, and in many smaller ones.

Mechanical loading methods other than with a Barber-Greene have been tried, but none of them, it is claimed, have been able to approach the 10-hour record made in Albany, when a Barber-Greene loaded more than 2,000 cubic yards into trucks or the average of 1,600 cubic yards maintained by the Boston Elevated Loaders, and similar performance by all other Barber-Greenes.

In two of the cities where other loading machines were said to have been successful, Barber-Greenes have since replaced them.

Three machines are necessary for the quick removal of snow; they are: The snow plow, the snow loader, and the motor truck.

A snow plow quickly clears a path to permit some traffic and at the same time piles snow into windrows for the snow loader. The snow loader picks up the snow and loads it into trucks which haul it away. This procedure is practical, simple, and fast.

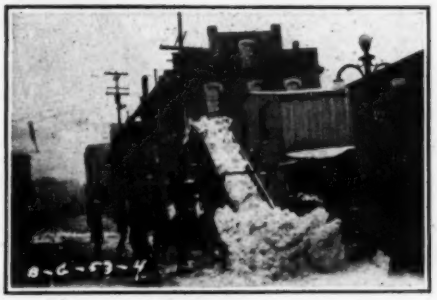
It utilizes the trucks to their maximum capacity and can be continued almost indefinitely. The maximum continuous run was maintained in Boston, when a Barber-Greene Snow Loader loaded trucks for 112 consecutive hours.

The storm which called out the Barber-Greene machine in Manchester for the first time was one of the worst blizzards experienced for more than two years in a country where the average snowfall is more than 60 in. in a winter. In 48 hours 21 in. of snow fell. A fierce wind caused drifting and tied up the train and trolley service throughout the country.

With a big tractor snow plow to windrow the snow into the gutters and a Barber-Greene to load the snow into trucks, the City of Manchester soon emerged from its snow cover.

Trucks were driven along with the traffic until they reached the snow loader which worked in the opposite direction. Loaded trucks moved without disturbing traffic.

Other snow handling equipment machines owned by this enterprising city are: One Holt 10-Ton Tractor equipped with a Sargent tractor-plow; four



**Two Views of Barber-Greene Snow Loader at Work in a Snow-Clogged Thoroughfare**

Champion Blade Plows which are attached to 5-ton trucks such as White, Mack, Packard, and Federal; one Sargent Truck Plow.

Madison, Wisconsin, having an average annual snowfall of 35 in. and a population of 40,000 is too big to allow blocked streets. Business in Madison suffers from a snow blockade in relatively the same degree as the largest city in the country. In Madison the city officials considered the city too large to allow snow to get the better of them. They now have a Barber-Greene Snow Loader.

And on the other hand, the city is small enough so that the snow problem can be almost completely solved by the application of one Barber-Grene. A city which uses 50 to 200 shovelers to remove snow can solve its snow removal problem almost completely by the purchase of one machine. In this way, a medium sized city can solve its snow removal problem more easily than a larger city which must purchase several machines to replace thousands of shovelers.

**Fox Snow Loader.**—Here is a loader that will dig and load snow into motor trucks in a single operation. It is said to load at the rate of 100 yds. per minute, and travel at the rate of ½ to 15 miles per hour. This loader, which discharges into a truck at either side or rear, is made of steel throughout, and equipped with Hyatt roller bearings. The esculator can be raised or lowered automatically in 10 seconds, say the manufacturers. If trucks are not available, the snow can be cast to the side of the pavement. In Chicago, one of these loaders could load a truck in 35 to 55 seconds, and kept 10 trucks busy. In Cleveland, the machine loaded 420 trucks in an 8-hour shift after one storm, with each load about 6½ cu. yds., according to the manufacturers. This loader is manufactured by the Fox Rotary Snow Broom Co., 2 La Fayette St., New York City.

**Mattson Snow Fence.**—Snow fence, used to protect cuts and other locations where drifts ordinarily form across the roadway, will materially lighten the work of the plows by causing the drifts to form at a predetermined place away from the pavement. The fencing is readily removed to storage in the spring, and easily erected in the fall. One successful type of snow fence is that manufactured by the Mattson Wire and Manufacturing Company, Joliet, Ill. This fence is made of heavy hardwood pickets woven between the best grade galvanized Bessemer steel wire, according to the manufacturers. The wire is tightly twisted to prevent slippage of the pickets, and pickets have their tops perfectly even. This type rolls up in convenient lengths and is easily installed in the late fall and removed in early spring.

**Link-Belt Snow Loader.**—The photograph on this page shows a Link-Belt "Grizzly" loading snow into 5-ton trucks on the Parkway in Philadelphia, at the rate of a truck in a little more than a minute.

The machine, designed and built by Link-Belt Company, Philadelphia, turns completely around in practically its own length—a feature of real advantage on a thoroughfare such as the one on which it was working. Heavy crawler treads, together with a reserve of power, enable it to walk into the snow; its construction is such that the snow is gathered and brought to the buckets almost without the assistance of hand labor, according to some claims that have been made by the manufacturer. There were but three men working with the machine—one operator and two to clean up.

The use of this loader is determined only by the season, as in warmer months, or during one of those seasons known colloquially as "an open winter," this same machine will be found handling sand, stone, gravel or coal.

**Haiss Snow Loader.**—The Haiss Snow Loader shown in the photograph is one owned by the City of New Bedford, Mass., shown at work during their snow removal campaign. It is used to load piled snow into motor trucks.

Haiss Snow Loaders, manufactured by Geo. Haiss Mfg. Co., New York City, are said to have a loading capacity of 10 to 15 cu. yd. per minute. They are equipped with feeding and cutting propellers which cut a swath 8 ft. wide and as the Loader is equipped with a slow speed worm drive that pushes it into the pile at a speed of 9 ft. per minute, this combination will dig not only snow but frozen snow as well as ice, claim the manufacturers.

It is equipped with a 41 HP. Wau-

kesha engine having a Ricardo head, is creeper mounted and will travel anywhere. It is equipped with the Haiss manganese feeding propellers and clean-up scraper to do away with the pick and shovel.

The mounting is the Haiss Creeper chassis and the Snow Boom is of the flight type of steel plate trough 33 in. wide equipped with flights 11 in. high, 24 in. apart, carried by manganese elevator chain. The crowding speed is 9 ft. per minute which can be used for heavy digging or 65 ft. reverse speed for light digging. The elevator boom is adjusted by the Haiss worm and jack knife raising device which means the operator can raise the boom quickly if necessary. The flights are ¼ in. steel plate, bent to give a cutting action on the tail shaft, and are equipped with teeth.

**The Eureka Snow Plow.**—The W. M. Toy Company, Sidney, Ohio, manufactures a small steel snow plow, horse drawn, that is especially designed for clearing sidewalks. While of primary interest to the municipal authority, these little sturdy plows could well be used for such other purposes as plowing a path along the roadside so as to keep school children and other rural pedestrians off the pavement, and to clear sidewalks on bridges, to clear walks in the small villages through which the state forces or county forces maintain a highway snow removal plan, and for similar jobs too small for the big plows. This plow is of all steel construction, of the "V" type, has wings that are designed like those on the large modern plows, the wings are easily adjustable for desired width of cut, provision is made for the plow to ride over obstructions automatically, anti-skid provision is also made, and a comfortable seat is provided for the driver. Either wing can be removed to afford a tool for cleaning gutters and ditches. The plow is sold complete, ready to hitch to and get to work. Three sizes are provided, affording equipment with blade depths of 12 in. to 24 in., and blade lengths sufficient to make cuts of 3 ft. to 9 ft.

**Joy Snow Loader.**—The Joy Manufacturing Company, of Franklin, Pa., holding basic patents on a mechanical gathering device, has developed a loading machine for decreasing the cost of snow removal from city streets. The working head of this machine is an exact duplicate of the well-known Joy device, which is used by the coal industry.

The Joy Snow Loader has capacities for any character of snow and will load from 10 to 20 cu. yd. per minute. The design and construction of this unit is based upon the extensive manufacturing and field experience gained by the solution of widely varying mechanical loading problems.


Link-Belt "Grizzly" Loader Handling Snow

Operated by one man, at high gathering and delivering speeds, over any kind of paving, the Joy Snow Loader is designed for rapid clearing of streets and roadways, and for loading fresh or frozen windrows of piled ice and snow into trucks. The machine consists of two main units.

A steel chassis mounted on solid rubber tired wheels, carrying a Hercules Model "G" four cylinder gasoline power unit, operative at 6 speeds forward and 2 speeds reverse, with forward speeds ranging from 74 ft. per minute to 12 miles per hour.

A steel conveyor frame mounted on the chassis at adjustable angles for operation, and for low clearance when traveling, carrying the Joy patented gathering mechanism, consisting of two


Haiss Snow Loader at Work

The Joy Snow Loader, Recently Introduced

rotating arms which sweep the material into the conveyor delivering to trucks through a swing chute.

**The Gettelman Hi-Speed Snow Plow.**—The Gettelman Hi-Speed Snow Plow, manufactured by the Heil Co., Milwaukee, was designed to meet the conditions of modern snow removal programs where high speed plows are placed on the highway soon after a snow storm begins and, if the fall is heavy, the plows stay on the job twenty-four hours per day until the storm subsides and the highways are cleared. Not only is this method less costly, but the highways are actually open all of the time, full width, instead of being blocked for days following a storm. State Highway Departments find that tax revenues from increased gas consumption, made possible by open highways, actually pays for the removal of snow under this plan.

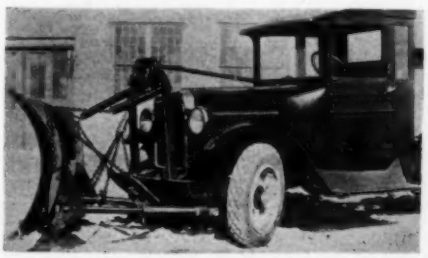
Any truck of two tons capacity or larger can handle a Gettelman snow plow at 20 miles per hour or faster, it is claimed. Dry snow has been handled by two-ton trucks travelling at 35 miles per hour, and wet snow at a slower speed, depending on the depth of the snow, say the manufacturers. Snow that weighs 45 lb. per cubic foot is considered as wet snow.

Travelling in wet or dry snow at the speeds mentioned, the snow will run up the curved blade in a sheet and spread itself evenly across the roadside and into the field much like a sheet of water spread by a speed motor boat or hydroplane, it is said. The snow from one storm spread in this manner does not pile up a windbreak that would cause the snow from a second storm to immediately drift into the roadway.

One county, with nine Gettelman plows attached to their regular road-building and maintenance trucks, following this program, keeps more than 250 miles of main travelled highways open at all times. For side roads and emergency service several tractor units are maintained, but these nine plows cost less than one heavy duty V-shaped plow and tractor.

The Gettelman Hi-Speed Snow Plow is made in 9-ft. lengths for 1½ to 2½ ton trucks and in 10-ft. lengths for 3-ton trucks and larger. All blades are 38 in. high. For light duty trucks short push arms place the center of the blade 46 in. from the center of the front axle. Longer push arms for heavy duty trucks make this distance 56 in.

Steel plate ¼ in. thick is used in the blade. The cutting edge is made of high carbon steel and this plate is reversible, thereby doubling its life. Structural steel angles reinforce the curvature of the blade and the cutting edge. The push arms are telescopic, seamless steel tubes affording maximum



Blade Type Gettelman Plow Mounted on Front of Motor Truck

strength at minimum weight. A universal front axle attachment secures the pusher arms to any make and model of truck. The hoist frame, winch, and cab control rod are light but sturdy in construction, and the plow is easily raised to carrying position because the worm and gear are machine cut. Tension type springs are easily adjusted to plowing conditions. All castings are electric steel, thoroughly annealed and machined to jigs, assuring standardization of parts.

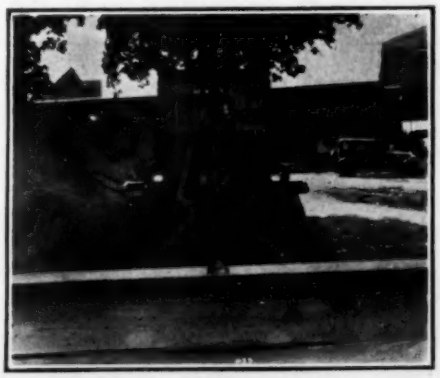
The installation of the plow on any truck requires only a few hours and is a very simple job, it is claimed, and once the installation is made, it requires only a few minutes to detach the plow or attach it again.

There are but three possible positions for the blade and these have been predetermined by scientific tests. The telescopic push arms permit quick adjustment of the blade to throw the snow to either side of the road, or the blade may be adjusted squarely across the front of the truck for bull-dozing snow at street intersections or other wide areas.

One of the features of the plow is the tripping action of the blade which protects it against damage from any obstructions it might hit. The blade is pivoted to the push arms so it can tilt forward, and the tension springs and the counter-balancing effect of the snow brings the blade back to the scraping position immediately. The deeper the snow the more it helps to return the blade to the operating position because the pivoting point is below the depth of the snow against the blade.

Another feature is the offset of the blade in respect to the truck. The discharge edges extend a foot beyond the truck wheels. This offset minimizes the side draft because the pressure of the snow on the offset portion of the blade throws the pressure line to the rear of the steering knuckle of the front wheel. This tends to make the truck nose toward the discharging snow instead of away from it, the manufacturers claim. Then, too, the truck can stay on the pavement and still clear the snow beyond the edges of the concrete. With chain drive tracks it is possible to plow close to the curve and yet keep the snow from getting into the chains and causing extensive wear of the jack shaft bearing. The correctly predetermined angle of the blade also minimizes a side draft.

**Pneumatic Snow Plow Lift.**—The Good Roads Machinery Company of Kennett Square, Pa., for years the pioneers and leaders in the snow plow industry, in collaboration with the White Motor Truck Company and the Westinghouse Air Brake Company, has developed and placed on the market a pneumatic lift for snow plows attached to trucks and busses that is unique and novel. It is believed to be the first application of compressed air for the function of raising and lowering a snow plow suspended from the front of a motor vehicle, it is said. Prior to this development a second operator has been necessary on the driver's seat for the sole purpose of operating the manual



General View of Champion Model 10-C Blade Type Plow on White Truck, Equipped With Pneumatic Lift Outfit

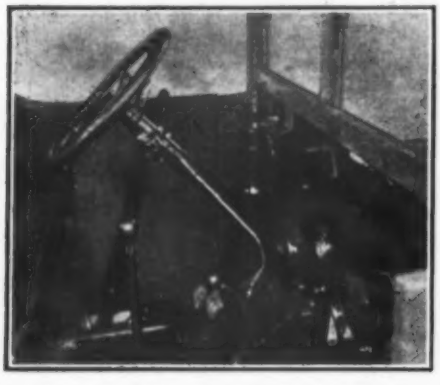
lift device of a snow plow. This entailed considerable added expense for comparatively intermittent and unskilled service, but absolutely necessary as it was out of the question to add this to the duties of the driver. This particularly applied to busses and made the problem here especially difficult, because, at best, no space was available for the plow operator. The simplicity and economy of the Good Roads-Westinghouse Pneumatic Lift insures its quick adoption by bus companies, truck operators, highway departments, transit companies, and others. The driver can subconsciously operate the snow plow by means of an air valve and a latch rope, without distracting his attention nor adding to his physical efforts.

The lift is operated by a vertical Westinghouse air cylinder attached to the "A" frame clamped to the chassis in front of the radiator. It is easily substituted for the prevalent hand hoist on existing plows. The lift chain is automatically locked when the air is shut off, but can be quickly released by pulling the trip rope. Trucks and busses equipped with air brakes require no further attachments than the air cylinder and lock. Those not equipped with air brakes can, with a modest expenditure, attach a compact Westinghouse Air Compressor to the timing gear box on the motor and the necessary air tank to the chassis. Tests show the time required to raise a plow with this device is counted in seconds instead of minutes formerly consumed by hand operation, the manufacturers claim.

It is common practice to leave the "A" frame on the front of the truck or bus during the snow season, as only a few minutes are then required for hooking on the plow when needed. However, the "A" frame is also readily removed when desired. This Good Roads-Westinghouse unit is suitable for any type of snow plow,—one-way, V, shovel nose, etc.

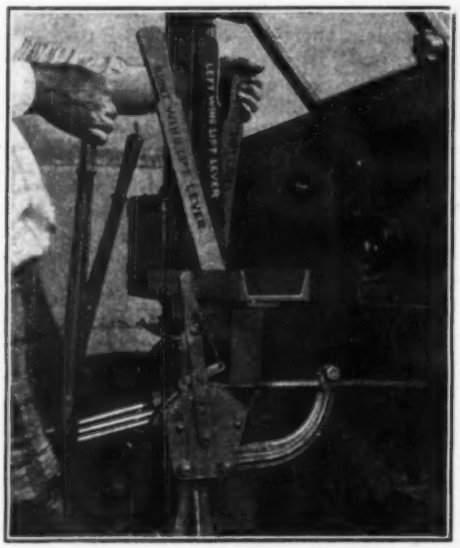
The entire combination is covered by patents and patent applications.

**LaPlante-Choate Plows.**—The greatest improvement which has been added to the snow plows manufactured by the LaPlante-Choate Manufacturing Co., of Cedar Rapids, Iowa, in recent years is an improvement added this year, namely, the putting of the hydrawlic controls in the cab of the tractor where the entire plow may be operated entirely by the tractor-driver. This feature eliminates two or three men ordinarily required to operate a snow plow, and it also enables the tractor driver to speed up his work considerably, the manufacturers claim.



The Control of the Pneumatic Lift Device

With hand-operated plows it is necessary to stop the tractor in order to make adjustments on the wings or "V". The wings on a snow plow have the same effect on the operation of same that the oars have on a boat, as far as side-draft is concerned. If you drag one oar, the boat turns in that direction, and the same is true with the wing on a snow plow. Consequently, since plows are generally operated in varying depth of snows, it is essential that the wings be raised and lowered frequently, to permit the tractor to maintain its forward motion without interruption. The tractor driver himself,

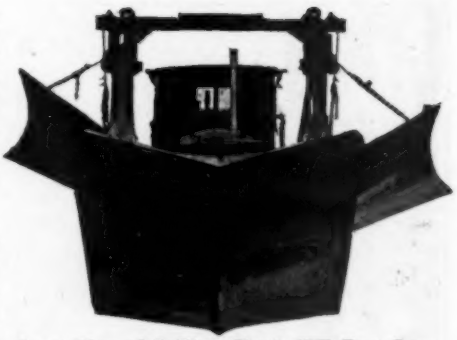


View of Controls on LaPlant-Choate Snow Plows

is the only person who knows when the forward progress of the tractor is being impeded by a wing dragging, and consequently, he should be in a position to raise or lower the wing which is causing his trouble, and to do it instantly.

With these new hydraulic controls in the cab of the tractor, he can raise and lower the wings instantly, without stopping the tractor. He can also assist the operation of the plow materially in other respects.

The mounting used on LaPlante-Choate plows, is such that the entire weight of the plow can be placed on the tractor for transportation or when needed to increase the traction. For instance if the tractor operator feels that the tracks are slipping in the soft snow and ice, all he needs to do, is to throw the lever which raises the plow and raise the plow up about an inch, and thus throw the entire weight of the plow on the tractor This weight will add traction to the tracks of the tractor, and in most cases prevent their slipping.



Front View of LaPlant-Choate "V" Type Snow Plow

**Trackson-Sargent Plow.**—A snow plow unit which is attracting attention this season among those who are familiar with snow removal methods consists of the McCormick-Deering 10-20 Industrial Tractor, with Model DH Trackson Full-Crawlers, and the Sargent Snow Plow which is especially adapted to mounting on this crawler tractor. This is manufactured by the Trackson Company, Milwaukee, Wisc.

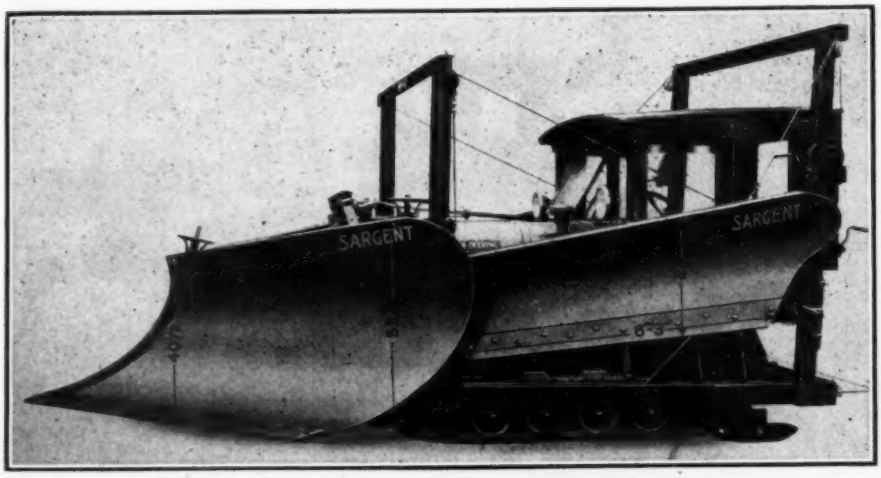
Neither of the machines which compose this unit is new in itself, but the combination is a recent development of interest. Highway officials, contractors, engineers, etc., are already familiar with the McCormick-Deering Industrial Tractor, the Trackson, and the Sargent plow.

The ample power provided by the McCormick-Deering takes the plow through deep, hard-packed snow or loose, fresh drifts, with the Trackson Full-Crawlers giving the unit positive traction, light ground pressure, and sure footing, say the manufacturers.

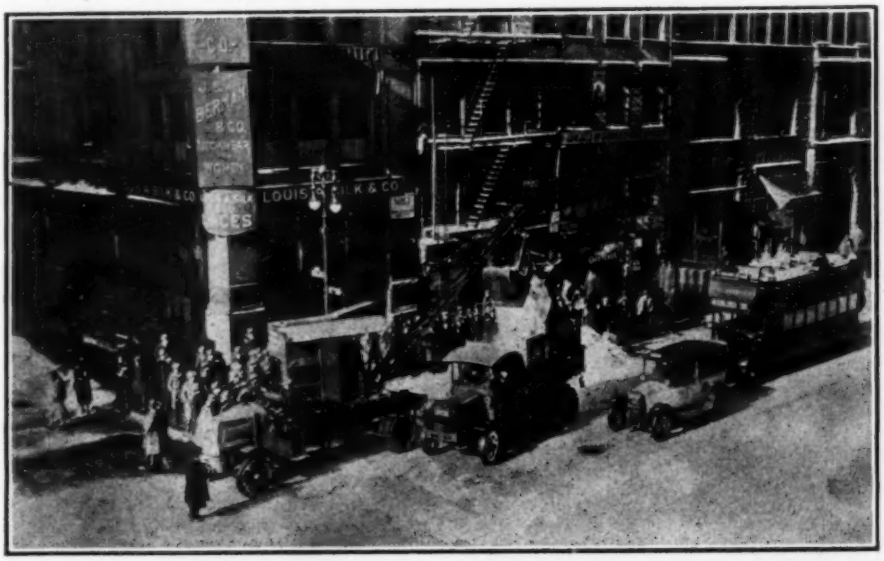
This model of the Sargent may be used either as a wing or as a V-plow. For an average fall of snow the wings may be spread to their full width of 17 feet, and for very deep, packed drifts they may be raised entirely and brought in close to the tractor, so that only the V-blade is left to plow the first channel. Or, when it is necessary to push back only one bank, either wing may be lowered and spread while the other is kept in the raised position, so that all of the power of the tractor is directed to the lowered wing.

Another feature of this plow is the fact that the V-blade may be let down so that it plows the snow right to the ground, or it may be raised an inch or two so that it will leave enough snow on the roads for sleighing.

One of the most important advantages of the Trackson McCormick-Deering snow plow unit is the fact that at the end of the winter season the Sargent Plow can be removed quickly and easily, and there will remain a 3½-ton crawler tractor ready for road construction or maintenance jobs, land clearing, dirt moving, and the countless other jobs which public works involve.




The Sargent Snow Plow Mounted on the Trackson-McCormick-Deering Unit



Universal Crane Handling Snow on Broadway, in New York City

Wehr Grader Clearing a Highway

This year-around usefulness is a big factor in the economy of any snow removal equipment, for most communities cannot afford to use a machine for only a few months and have it remain idle in storage for the rest of the year.

**Crane Loads Truck.**—Cranes such as the Universal are often used for loading piled snow into trucks, and for clearing unusually heavy drifts too deep for the plows. The Universal has been used in several cities such as Detroit, Chicago, Syracuse, Utica, Rome, N. Y., New York City, etc. In New York City, as many as thirty motor truck mounted Universal Cranes have been used during the heavy snow months of latter January and February.

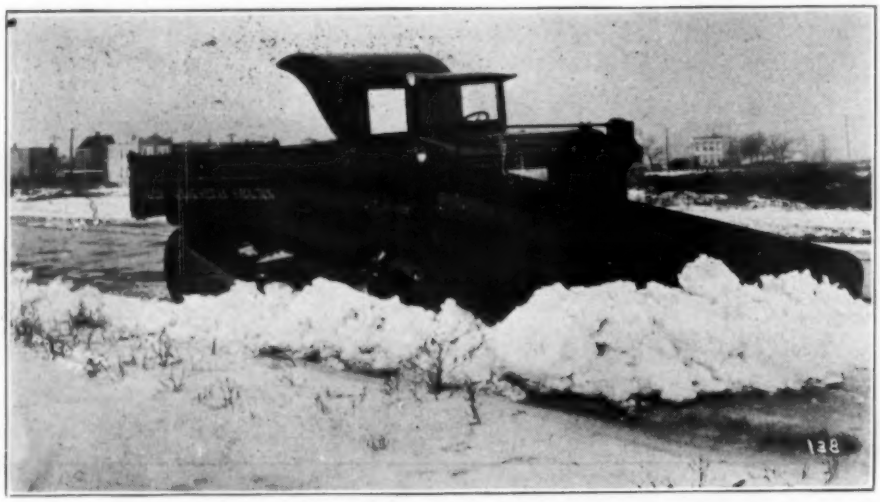
The photograph shows such a unit operating on Broadway in New York City.

Various data collected on the ability of these machines to handle snow, according to the manufacturers, shows that they can easily load an average of 9 to 10 cubic yards into trucks in 2½ to 3 minutes. In the city of Syracuse, the commissioners of Public Works, stated that the city machine saved $2.00 a truck load on loading the snow. The usual procedure in using the crane unit is to clear the streets of the snow piling it into the big windrows at the side of the streets which are then loaded by the crane unit. One and a half cubic yard snow buckets are used on the crane, and the trucks can be equipped with high side boards so that they can haul nine to ten yards at a trip. One of the main advantages of the unit is that after the snow freezes and the piles get rather hard the clamshell action of the snow bucket is able to bite through without very much difficulty and handle the frozen snow and ice. Occasionally the units have been equipped with ¾ yd. digging buckets and teeth to handle some of the exceptionally hard packs of icy snow.

Another feature of the unit is the motor truck mobility so that they can become busy on various other jobs when they are not required for snow removal work, and can be easily transported into congested districts when the storm suddenly comes up. The Borough of Queens, New York, has recently purchased four Universal Cranes, all motor truck mounted, to be equipped with 1½ yd. snow buckets in reserve for snow removal work in New York and vicinity this winter. These units, like other Universal Cranes, are adaptable to 101 other uses throughout the balance of the year. This crane is manufactured by the Universal Crane Company, Lorain, Ohio.

**Wehr Graders.**—These graders, manufactured by the Wehr Company, Milwaukee, Wis., are used with a scarifier to remove ice, and with the grader blade to windrow the snow and any ice that can be moved by this means. These are one-man power graders built around a light tractor, and are useful

for patrol purposes in the summer. A typical instance of ice removal has been reported from Queen Victoria Park, Ontario, Canada, next to Niagara Falls. At this location the spray from the falls collects on the main driveway, and in the winter as much as 6 to 18 in. of ice will form on the drive in the course of one night. This drive is 36 ft. wide and the section subjected to this ice formation is 1,500 ft. long. The ice is first broken up with the Wehr grader equipped with a nine tooth scarifier, this operation taking about one hour with 12 in. of ice. The blade was next used, and the ice removed in about two hours. This method saved about two days time over pick and shovel methods, and the saving in cost was reported to be about $150,000, and the road was kept open. On ordinary snow removal, this grader is said to keep from 18 to 20 miles of road open throughout the season at a cost of less than $8.50 a day.



The Walter Snow Fighter, a Truck Type Plow

**Walter Snow Fighter.**—A photograph on this page shows the Walter Snow Fighter with the patrol plow and the center scraper pressure blade and equipped with a low level type of dump body, as extensively used by state and county forces.

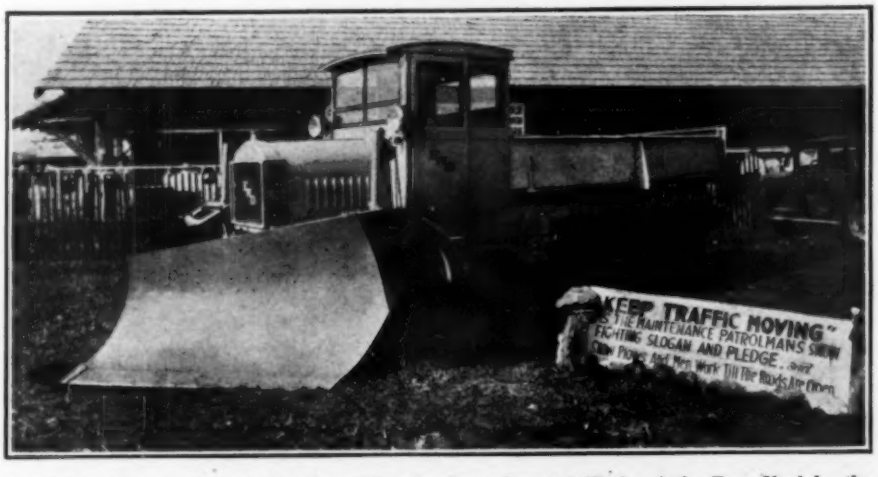
The Walter Snow Fighter manufactured by the Walter Motor Truck Company, Inc., Long Island City, N. Y., has been especially designed and constructed for snow displacement service. There is a positive drive to all four wheels under all traction conditions. This is obtained by means of patented automatic lock differentials. The motor is of the heavy duty six-cylinder type and developing over 100 H. P. This, together with the special 10 to 1 range transmission, makes possible maximum speed for all snow conditions.

The front plow has been designed to pour and throw the deep snow off the road and out of the way. The center pressure scraper blade can scrape right down to the road surface removing all packed snow and ice. This center pressure scraper blade is provided with suitable cushion springs to prevent damage.

These units are equipped with dump bodies either of the sand and gravel type, or with flusher tanks and road oiling equipment so as to make them serviceable the entire year.

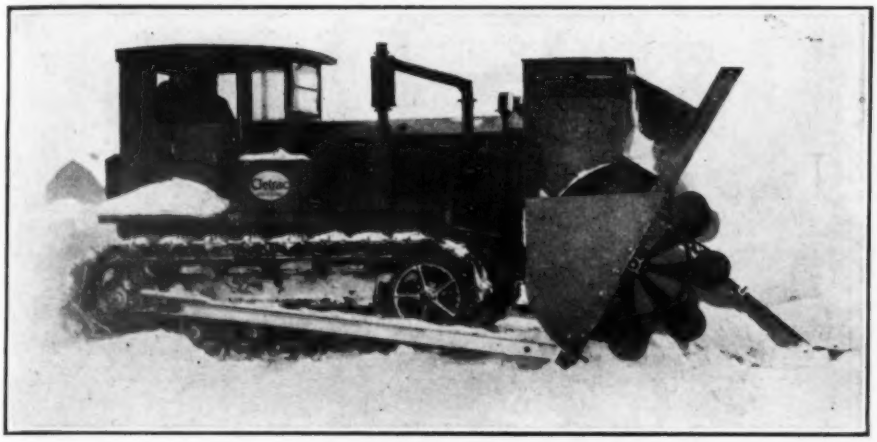

Bucyrus-Erie Shovel with 4 Cu. Yd. Dipper, Opening the Snoqualmie Pass in Cascade Mountains, Washington

**Bucyrus-Erie Shovels.**—Some state forces have made use of a steam shovel or gas shovel for clearing particularly heavy drifts, especially in mountain passes. This is said to be a good method. A photograph in this issue shows a Bucyrus-Erie Shovel with 4 cu. yd. dipper opening the Snoqualmie Pass, in the Cascade Mountains, in the State of Washington. It is often the practice when using shovels for snow removal work to replace the standard dipper with a special one of about 4 cu. yd. capacity that has been developed for

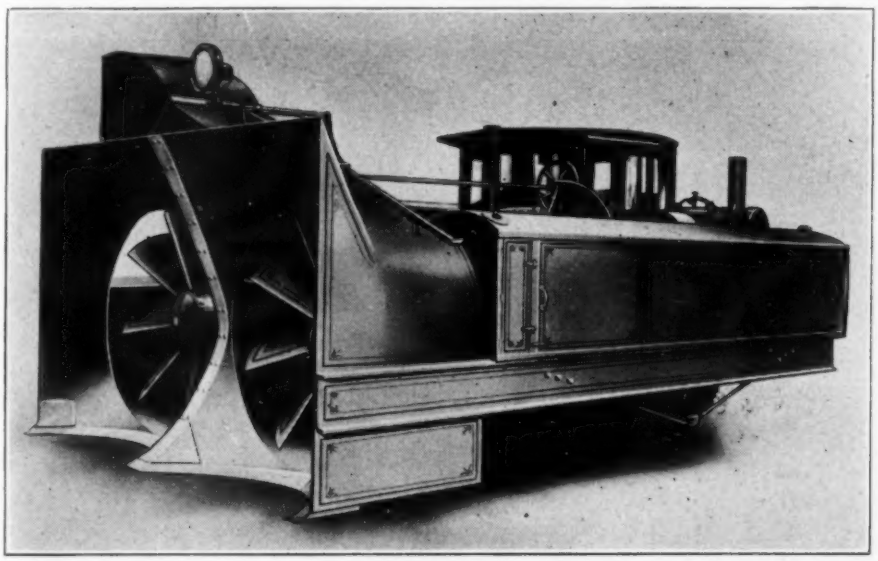



FWD Truck Equipped with "V" Type Plow for Snow Removal Work, of the Type Used by the Missouri State Highway Department

the purpose since snow is a relatively light material except when it has been converted to ice by a thaw followed by a sudden freeze before the removal work can be completed. Thus, in an emergency, a shovel can always be rented and relied upon to do good service. This particular shovel is so well known as to need no description at this time. It is manufactured by the Bucyrus-Erie Company, Erie, Pa.



Cletrac Equipped With Snow King Rotary Plow



The Edwards Rotary Snow Plow

The Edwards Rotary Snow Plow at Work on a Heavy Drift

**FWD With "V" Plow.**—At the Missouri State Fair this year, the Missouri State Highway Department exhibited as one of their types of snow removal equipment a FWD truck equipped with the "V" type plow shown on this page. This is a high speed plow that throws the snow to the side of the pavement for future attention, and is equally applicable to municipal work, where the snow is first piled along the curb by such plows and then loaded into trucks for disposal. The FWD truck is manufactured at Clintonville, Wisc.

**Cletrac With Rotary Plow.**—A photograph on this page shows the Cletrac Model "100" equipped with a Snow King Rotary Plow and used last winter by the State Highway Department of Michigan. This is a very efficient outfit, particularly where the snow is heavy and deep drifts have formed. The Cleveland Tractor Company, Cleveland, O., also builds a complete line of Cletrac Crawler Tractors, consisting of four models, all of which are equally adaptable for winter use. Various snow plows have been adapted for each of these models so that the manufacturers are in a position to furnish the power requirement in almost any instance where a tractor can be used for keeping roads open during the winter season.

**Edwards Rotary Snow Plow.**—One rotary that has been reported is that manufactured by the C. D. Edwards Manufacturing Co., Inc., of Albert Lea, Minn. This rotary clears a strip 13 ft.

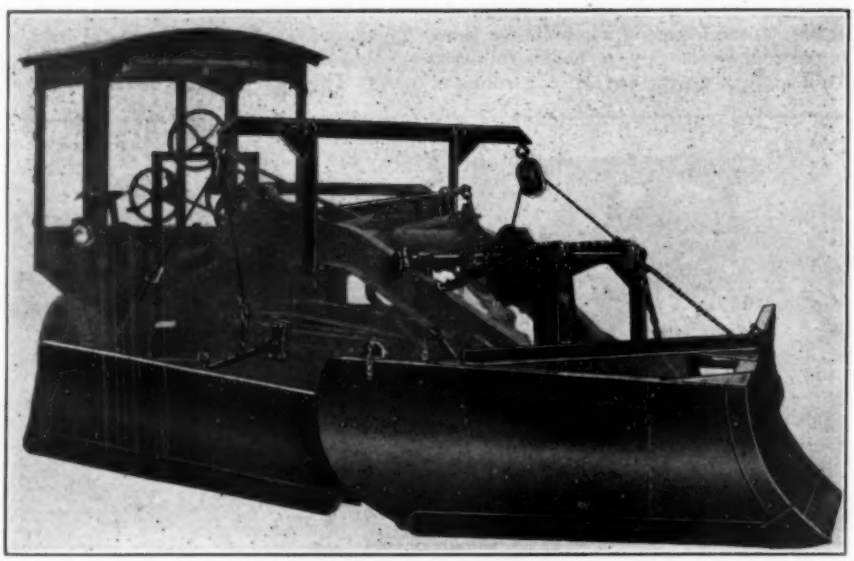
Cletrac with Sargent Plow, Used for Bucking the Heavy Drifts

wide in one trip and throws the snow clear of the pavement. The plow is built with two individual motors which furnish power for revolving rotors. Both motors are equipped with electric starters and automatic governors, allowing the operator to give his full attention to the driving of the plow. The motive power supplied is the 10-ton Caterpillar tractor. While the plow will handle all normal obstructions, a shear pin has been provided in each rotor to prevent damage should fence posts, logs and other major obstructions be encountered. Because of the design, side-draft is said to be eliminated, and because the plow is mounted at the center of each track of the tractor, putting no weight on the tractor frame, there is no tendency to ride over the work. Depth of cut, it is said, can easily be controlled from the cab. The weight, including the tractor, is 38,000 lb., he length overall is 30 ft., the height overall is 12 ft., and exclusive of the tractor, the plow delivers 200 h.p. Equipment is standard automotive equipment, and ample fuel capacity is supplied.

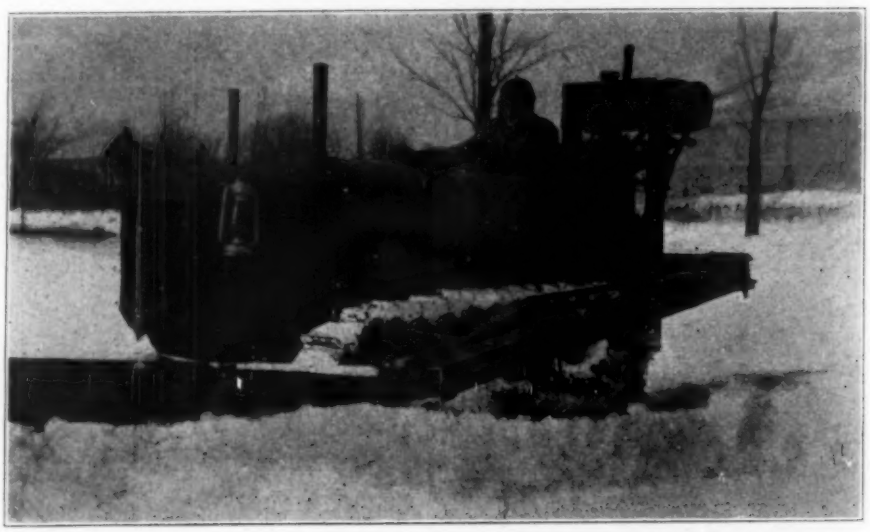
**New Adams Snow Plow.**—J. D. Adams & Company of Indianapolis, Ind., have just announced a new snow plow for use on their motor graders—the No. 10 with McCormick-Deering Tractor and the No. 11 with "Caterpillar" 20 Tractor. This plow designed with the cooperation of the LaPlante-Choate Company, leading snow plow manufacturers, is of the same type successfully used on truck throughout the country by state and county highway departments. When lowered the plow rides on three caster wheels with a road clearance of about 1 in. The plow is very readily raised by the hand control in the operator's cab. Wings are optional, but are recommended. They are fully adjustable vertically and in and out to meet the various requirements encountered in snow removal.

The plow is said to be very strongly built throughout and well braced. The plow proper cuts to a width of 8½ ft. With wings the cut can be increased to 16 ft. The plow is 29 in. high in front and 33 in. at the rear. At any time during the winter it is desired to remove the snow plow from the grader temporarily it may be disconnected in a very short time, the upright lifting frame being left on the grader as it in no way interferes with the normal action or adjustment of the machine.

**Caterpillar Tractors and Snow Plows.**—As might have been noticed in the foregoing pages, a wide variety of snow removal equipment has been designed for use with the Caterpillar tractor, manufactured by the Caterpillar Tractor Co., San Leandro, California. The Caterpillar has been noted for stamina and power and general reliability, and it is these things that are of particular importance in any motive



New Adams-LaPlant-Choate Snow Plow



Caterpillar 30 and LaPlant-Choate Blade Plow at Work on Light Snow

Caterpillar 27 and "V" Type Plow in Canada Working on Heavy Drift

Caterpillar and Snow King Rotary Used on State Work

Russell Motor Patrol Used for Snow Removal Work

The Warco Snow Plow Working with the Warco Grader

power for snow removal work, a service that is one of the most severe. Caterpillars have been found working with blade plows, "V" type plows, rotaries, and with scarifiers and other equipment for ice-breaking, both on municipal and rural work. Practically all plows are adjustable to leave a sleighing surface when desired.

Sometimes a drag is used, made of fitted timbers connected behind the plow, and clearing a 30-ft. strip. A cab mounted on the tractor provides sleeping accommodations in order that the plow can be kept working continuously night and day, with one operator sleeping in the cab while the other is at work. Other devices seen include the ice-breaking scarifier, cleated rollers for ice, elevating loaders of the bucket and belt types, grab buckets, skimmer scoops, special tractor loaders with snow buckets, power shovels, explosives, and pneumatic tools. A combination plow and loader has been developed, used in about the same manner as an elevating grader. Another new development is the adoption of one-man maintainers, powered with the 2-ton Caterpillar, for snow removal work. Special types of grousers and tracks are available to meet any special conditions that the Caterpillar may be called upon to encounter in snow removal work.

**The Warco Snow Plow.** — Designed for use with the Warco line of one man graders, the Warco snow plow is said to approximate $14.69 per mile, while to have proven to be a very efficient means of clearing highways of snow.

Removing the scarifier from the grader, the plow is readily mounted in place of the scarifier. If the grader is not equipped with a scarifier the plow can be attached with no trouble by an unskilled mechanic in a short time, say the manufacturers.

The ordinary fall of snow can be cleared away quickly utilizing the plow only, it is said, but a heavy snow fall will require the use of the grader blade in addition to the plow. In employing both cutting edges the plow is raised and the blade lowered. When raised the plow clears the ground by 11 inches; this brings the highest point of the plow 41 inches above the ground line.

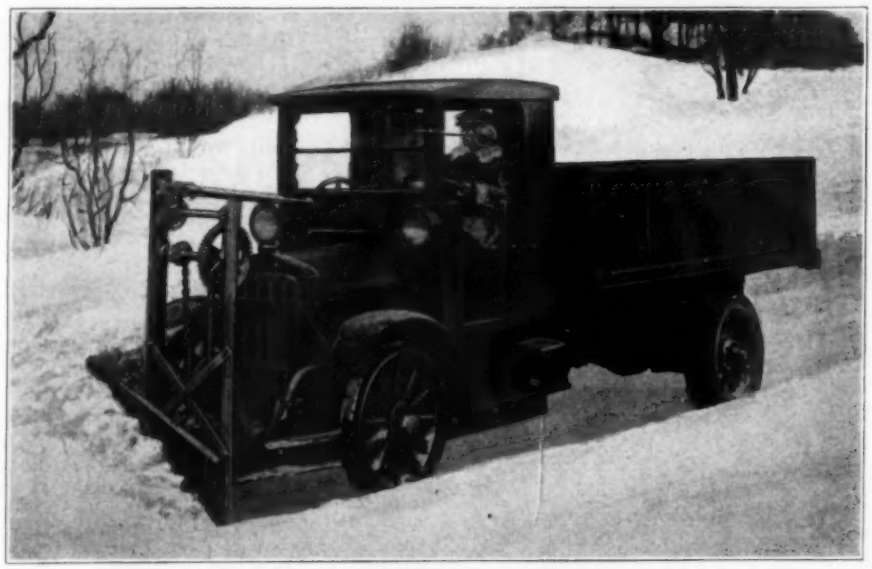
The Warco snow plow is said to be substantially built, and on account of its cheapness, low maintenance cost and one man operation, is claimed to be an economical means of keeping traffic moving during the winter months. The plow will increase the earning power of a grader, since the grader can be used during practically the entire year. The plows are manufactured by the W. A. Riddell Company, Bucyrus, Ohio.

**Western Snow Plows.**—According to the literature of the Austin-Western Road Machinery Co., 400 N. Michigan Avenue, Chicago, Ill., experience has shown that the most practical snow plow for average working conditions is one attached to the front of a motor truck. It is almost always possible to fight the snow as fast as it falls, and by using comparatively high speed equipment like motor trucks, and covering a large mileage of pavement as fast as may be necessary, the snow is prevented from drifting and the roads and streets kept open at all times.

Western Snow Plows are made in both straight blade and "V" shaped types, both of which can be mounted on any two-ton or larger motor truck. One of the features of Western plows is that these two types are convertible; in other words, both types of blades fit on the same general framework—the substitution of one blade for the other being but the work of a few minutes—and the operator who does not have constant use for both types of blades, but who is likely to need first one and then the other at some time during the winter, is thereby relieved of the expense of purchasing complete plows of both types.

While conditions naturally vary to a great extent in different localities, it can safely be stated that the straight blade type of snow plow will work the most satisfactorily and economically under average operating conditions. There are times, however, when the situation is reversed, and the work can best be handled by the "V" shaped type of plow. With other makes of plows it is necessary for the owner to invest in at least one complete plow of each type in order to be prepared to meet all operating conditions successfully; this in spite of the fact that he will probably have comparatively little use for the "V" shaped plow. On the other hand, the convertible feature of Western plows, whereby either the straight or "V" shaped type of blade can be attached to the same framework, makes this extra investment in equipment unnecessary. The owner who is only going to be using one plow at a time simply buys one complete plow of either type, and an extra blade of the other type; while the owner of a fleet of plows can buy, say, six complete plows of the straight blade type and one or two extra "V" shaped blades for use in emergencies.

The straight blade Western Snow Plow has a 10 ft. moldboard made of ⅛ in. steel, flanged at the top and bottom to strengthen it laterally, and provided with a removable 6 in. cutting edge or bit which gives the blade a total height of 21 in. The blade is reinforced vertically by six 2½ in. x 2½ in. x ¼ in. open hearth steel angles, and longitudinally by a 3 in. x 3 in. x ½ in. angle to which is fastened the blade circle. When set at the normal plowing angle of about 30 deg. this 10 ft. blade cuts a path about 8 ft. wide, and, of course, throws all of the snow to the same side. The blade is properly shaped to roll rather than push the snow, and all the rivets in the face of the blade have countersunk heads to provide an absolutely smooth surface, which does not interfere with the movement of the snow as would projecting rivet heads.



Views of Western Snow Plows at Work

The "V" shaped blade cuts a path 8 ft. 4 in. in width and, of course, throws the snow from the center to both sides. The blade is 34 in. high, including the removable cutting edge or bit, which takes all the wear and is made in two pieces, one for each side of the "V." A replaceable steel nose casting fits over the blade and bits and stands the greater part of the abuse to which the "V" shaped type of plow is quite likely to be subjected.

The blade itself is made of ¼ in. stock and the plow as a whole is very substantially constructed and therefore able to buck heavy drifts successfully, not only because of its weight and strength but also because of its being attached to the frame of the truck near the rear axle, instead of to the front axle.

**Acme Snow Plow Outfit.**—The Acme Road Machinery Co., Frankfort, N. Y., manufacturers of road graders and pony rollers, manufacture a snow plow outfit that is based on a choice of three power plants, the Hercules Model 0 motor, the McCormick-Deering Tractor power plant, or the Fordson power plant. It is so built that the outfit can serve as a grader in the summer and a snow plow in the winter months. Wheels or crawler mountings are available as desired. The plow includes an underbody blade, a V type plow up front, and two side wings that can be elevated and set as required. The transmission is such that more power is made available than is ordinarily used in tractor installations of these power plants, say the manufacturers. The plow rig can be obtained separate and mounted on the tractor equipment already on hand, or the complete outfit can be purchased if desired. A scarifier attachment can be supplied for the removal of ice from the pavement.